1935

The University of Tennessee Agricultural Experiment Station. Fourty-Eighth Annual Report, 1935

University of Tennessee Agricultural Experiment Station

THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION

FORTY-EIGHTH ANNUAL REPORT

1935

KNOXVILLE, TENNESSEE

THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXPERIMENT STATION
Knoxville

JAMES D. HOSKINS, President

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J. O. ANDES, Asst. Plant Pathologist
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G. M. STONE, Asst. Plant Pathologist
E. S. BROWN, Asst. in Plant Pathology

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L. R. NEEL, Supt., Middle Tennessee Experiment Station, Columbia
F. S. CHANCE, Supt., Tobacco Experiment Station, Greeneville*
LESTER WEAKLEY, Asst., Mericourt Experiment Station, Clarksville

*Cooperative with the U. S. Department of Agriculture.

The Agricultural Building, containing the offices and laboratories of the Experiment Station, the College class rooms, and the headquarters of the Agricultural Extension Service, is located at the University Farm, on Kingston Pike, about one mile west of the main campus. Farmers are cordially invited to visit the building and the experimental grounds.

Bulletins of this Station will be mailed free to any farmer in the State. Write Agricultural Experiment Station, University of Tennessee, Knoxville, Tennessee.

LETTER OF TRANSMITTAL

Knoxville, Tennessee, January 1, 1936

To His Excellency, Hill McAllister, Governor of Tennessee.

Sir: I have the honor to transmit herewith, on behalf of the Board of Trustees of The University of Tennessee, a report of the work and expenditures of the Agricultural Experiment Station for the year 1935. This report is submitted in accordance with the law requiring that the Board having direction of the Experiment Station shall annually submit to the Governor of the State a report of its operations and expenses.

Very respectfully,

JAMES D. HOSKINS, President.

THE UNIVERSITY OF TENNESSEE

AGRICULTURAL EXPERIMENT STATION

In account with

The United States Appropriations, 1934-1935

Receipts

	Hatch Fund	Adams Fund	Purnell Fund
U. S. Treasurer	$15,000.00	$15,000.00	$60,000.00

Disbursements

Personal services	$12,698.87	$13,911.89	$50,198.91
Supplies and materials	455.60	395.80	2,321.01
Communication service	377.35	2.98	22.22
Travel expenses	112.43	216.66	1,159.40
Transportation of things	10.16	35.67	348.62
Publications	907.20	.....	373.76
Heat, light, water, and power	25.39	41.11	133.81
Contingent expenses	5.16		125.58
Equipment	407.84	329.80	3,649.60
Buildings and land	.....	66.09	1,667.09
	$15,000.00	$15,000.00	$60,000.00

FORTY-EIGHTH ANNUAL REPORT OF THE AGRICULTURAL EXPERIMENT STATION OF THE UNIVERSITY OF TENNESSEE, FOR 1935

INCREASED APPROPRIATIONS

The activities of the Agricultural Experiment Station during the year have been greatly enlarged, due to increased funds from the TVA for cooperative work and to a new and important Congressional appropriation, through the Bankhead-Jones Act, beginning September 1, 1935. The first year's allotment from the latter source was $18,695.97. This will be increased by a like amount each year for the next four years, provided an equal offset is furnished from State or private funds applied to research or experimental work in agriculture. The necessary offset was available for the first year and probably will be for the second year. Any increases for offset purposes thereafter must be especially provided from other funds.

The Bankhead-Jones Fund is for use in research on basic agricultural problems of the State. Two projects have been approved, one on erosion control by pasture farming and one on the home production of food supplies. The former project is being carried out near Greeneville, on a special farm for the purpose, for which Greene County contributed $4,000.00. This new farm adjoins the Tobacco Station farm and was deeded to the University for Experiment Station purposes. The attitude of Greene County farmers toward the University and the Experiment Station is highly gratifying. The project on the home production of food supplies has been located at the Cumberland Homestead, near Crossville. Twelve farms are to be used, all on new land and under circumstances unusually favorable for this project, which is considered peculiarly important under present conditions of unemployment. The judicious use of this fund, now and in the future, is expected to be materially beneficial to the interests of the State.

PROGRESS OF STATION WORK

One of the more important recent undertakings is a soil survey of the Tennessee Valley counties. The project is cooperative with the TVA and the Bureau of Chemistry and Soils of the U. S. Department of Agriculture. This survey is considered to be fundamental to an improved and better planned agriculture, including erosion control. In one respect, the failure to get soil surveys at an earlier date is advantageous, for the surveys now being made are far more valuable than those of previous years because of the superior technic now

followed. The survey of one county, Jefferson, was completed in 1935, and the surveys of four others are being rapidly carried out. It is hoped to complete all the counties of the Tennessee watershed in three or four years.

Appreciable progress is being made in the development of improved varieties of both fruits and field crops—in particular, raspberries and strawberries among the fruits; and corn, barley, and winter oats among the field crops. Also renewed effort is being directed to the getting of a more stabilized and disease-resistant red clover. Work of this kind may require years of time before worthwhile results are obtained. The same is true of most Station projects; and though some failures are to be expected, a single successful outcome may be worth far more than all the money spent on all the projects.

The trying out of new phosphates and the determination of the plant-food responses of the numerous types of soil found in the State continue to be live subjects of increased importance, due to changed conditions which affect the prices of both crops and fertilizer materials.

The most economical methods of feeding, including pasturing of livestock, is another subject that is being carefully pursued with encouraging results.

New plant diseases continue to appear, and require research both as to cause and cure. Some are closely related to or dependent upon nutritional defects in the soil. The nutritional troubles, in turn, sometimes result from a change in the system of cropping. The recent widespread production of lespedeza is giving rise to problems of this character and shows the need of trained specialists prepared to cope with problems as they arise.

The department of Entomology, like that of Plant Pathology, must be prepared for emergencies. In fact, close cooperation should exist between the two departments, especially as plant diseases are often carried by insects. The fluosilicates as insecticides were developed by the Tennessee Station and long ago showed their superiority for numerous purposes over the arsenicals commonly used. There arose, however, a great drawback to the extensive use of the fluorides through the placing of an apparently unjustified tolerance limit on the amount of this insecticide which could be legally carried by fruit and vegetables. A tolerance limit of .01 grain per pound of fruit is now in force by the Food and Drug Administration because a defect of teeth known as "mottled enamel" has been traced to fluorine in drinking water. The Station now has under way, in the Home Economics Department, a project which is expected to furnish evidence that mottled enamel is not likely to be caused by fluorine in spray residues.

Extensive information in regard to the larger aspects of agriculture has been accumulated by the Agricultural Economics Department during the past year and is of the greatest assistance in answering the numerous urgent inquiries from various sources, in particular those relating to proposed changes in general agriculture.

PUBLICATIONS

BULLETINS

The following bulletins were published during the year:

Bulletin No. 154—Lespedeza Sericea, by C. A. Mooers and H. P. Ogden. 20 pages. February, 1935. This bulletin was written with special regard to cultural methods, but the value of the crop for both hay and pasture, and for soil improvement, received attention as far as the information was available from the Station's experiments. On the whole, sericea promises to be a valuable crop, especially for hay and soil improvement, and its use as a farm crop is expected to increase greatly.

Bulletin No. 155—A Barium-Fluorine Study: The Fate of Added Barium Silicofluoride and Its Effect upon Sulphates and Other Soil Components, as Influenced by Limestone and Dolomite, by W. H. MacIntire, W. M. Shaw, and Brooks Robinson. 31 pages. June, 1935. This bulletin is of a technical nature and is of importance because of the increasing use of barium silicofluoride as an insecticide.

Bulletin No. 156—Winter-Finishing Two-Year-Old Grass Steers, by M. Jacob and H. R. Duncan. 12 pages. November, 1935. This bulletin gives the results obtained in 3 years' feeding trials with 2-year-old steers. The results were most favorable to the ration of normal corn silage and cottonseed meal; that is, the animals fed this ration made the most economical gains and were given the highest appraisal value. The addition of either corn or molasses failed to improve the results in most instances, but the corn proved superior to the molasses.

CIRCULARS

Circulars may be looked upon as brief, practical bulletins, giving results of the Station's investigations. Those published in 1935 are as follows:

Circular No. 52—Rye for Pasture and Seed in Tennessee, by L. R. Neel.

Circular No. 53—Tax Delinquency on Rural and Other Property in Tennessee: A Preliminary Report, by C. E. Allred, P. B. Boyer, and R. E. Horne.

Circular No. 54—The Root-Knot Nematode in Tennessee, by W. O. Whittle and Brooks D. Drain.

OTHER PUBLICATIONS

Department of Chemistry

MacIntire, W. H., Jones, R. M., and Hardin, L. J. Comparison of filtration by gravity and by suction in washing to remove water-soluble P_2O_5 from analytical charges. Jour. A. O. A. C., 18:301-306. 1935.

MacIntire, W. H., and Hardin L. J. A modified technic for the determination of citrate-insoluble P_2O_5. Jour. A. O. A. C., 18:297-301. 1935.

Shaw, W. M. and MacIntire, W. H.. The determination of absorbed bases by boiling ammonium chloride and the utility of the procedure in related soil investigations. Soil Sci., 39:359-375. 1935.

Shuey, G. A. A modified method for the removal of added ingredients from phosphated and self-rising flours in order to determine the ash content of the original flour. Cereal Chemistry, 12:289-294. 1935.

Department of Entomology

Marcovitch, S. Experimental evidence on the value of strip farming as a method for the natural control of injurious insects with special reference to plant lice. Jour. Econ. Ento., 28:62-70. 1935.

Marcovitch, S. Control of the bean weevil and the cowpea weevil. Jour. Econ. Ento., 28:796-797. 1935.

Stanley, W. W., and Marcovitch, S. Calcium arsenate as a control measure for the tobacco flea beetle and hornworm. Jour. Econ. Ento., 28:797-801. 1935.

Department of Home Economics

MacLeod, Florence L., Armstrong, M. R., Heap, M. E., and Tolbert, L. A. The vitamin A content of five varieties of sweet potato. Jour. Agr. Res., 50:181-187. 1935.

Department of Plant Pathology

Sherbakoff, C. D., and McClintock, J. A. The effect of crown gall, hairy root and woolly aphid on apple trees in the orchard. Phytopathology, 25:1099-1103. 1935.

CHANGES IN STAFF

NEW MEMBERS

Additions were made to the Station staff during the year 1935 as follows:

J. J. Bird, Associate Agronomist, beginning November 1. Mr. Bird is a graduate of Michigan State College, where he was employed for several years as a specialist in farm crops.

L. A. Fister, Assistant Horticulturist, beginning February 1. Mr. Fister is a graduate of the University of Kentucky, where he specialized in garden crops.

Dr. K. L. Hertel, Professor of Physics in the University of Tennessee, who did special work for the Experiment Station for several years in connection with a project on cotton, was appointed Physicist of the Station, on part time, September 1.

B. H. Luebke, Assistant Agricultural Economist, beginning September 4. Mr. Luebke is a graduate of Oregon State College, and received an M. S. degree from Kansas State College.

W. O. Whittle, Assistant in Agronomy, regularly employed by the Station since August. Mr. Whittle is a graduate of the University of Tennessee, and has done special work for the Station for several years.

RESIGNATION

G. H. Hatfield, Assistant Agricultural Economist since July 1, 1929, resigned June 30, 1935, to accept a superior position elsewhere.

Mr. Hatfield is a University of Tennessee graduate and did most satisfactory work throughout his connection with the Station.

OBITUARY

Mr. Samuel Henry Essary, Botanist, was one of the Station's most beloved workers. He was born in Henderson County, Tennessee, September 11, 1870, and died at Trenton, Gibson County, Tennessee, April 28, 1935. He was a graduate of the University of Tennessee, 1897. After spending several years teaching in Missouri and Georgia, he became associated with the Botany Department of the University of Tennessee in 1904, and took his Master's at this institution in 1907. He was assistant in the Botany Department of the University and the Experiment Station until 1919, at which time he was appointed Station Botanist, which position he held until his death. His outstanding achievements were his work on Tennessee Wilt-Resistant clover, the development of two wilt-resistant tomatoes—Tennessee Pink and Tennessee Red; and the development of Tennessee No. 76 lespedeza, which he secured by selection from the common Japan clover. Trice cotton, one of the best varieties for the northern limits of cotton production, was improved and introduced to general use by him.

In the death of Mr. Essary the Station lost a widely known and highly respected member of its staff. He had rare ability in the making of plant selections which proved to be real improvements suitable to wide practical use.

A TENTATIVE GROUPING OF TENNESSEE SOILS

From time to time, especially during the last two years, the Station has been requested to furnish information as to the amount and location of each of various classes of land found in the State. The matter is of importance in connection with the problem of suitable resettlement land and of submarginal areas which might well be taken over for either parks or forestry. Also the AAA needed information as to the amount of worth-while arable land in the State in order to complete their estimates. The answers to these questions would have been greatly facilitated had improved soil surveys been available for all the counties. Unfortunately, of the 95 counties, only 22 have been surveyed, and most of the surveys were made 25 or 30 years ago, when the technic of a soil survey had not been well developed. Since something in the way of a guide was needed, a method based largely on the 1930 census, for approximating the acreage of various grades of land in farms was worked out and applied to each county. The accompanying table summarizes the data by county groups. The only estimates taken directly from the census are those under the head of "Woodland not pastured."

Estimates such as are given in the table, aside from those for woodland not pastured, are of course liable to material revision when thorough surveys are completed, but are considered worth publishing as giving information of far more worth than the usual guesses.

Estimated acreages of various grades of land in farms by county groups

Counties	Grade 1 Good to rich		Grade 2 Medium		Grade 3 Marginal (adapted to pasture)		Grade 4 Submarginal (adapted to forest)		Grade 5 Woodland (not pastured)	
GROUP 1	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres	Per cent	Acres
Carter, Johnson, Unicoi.	13	36,015	22	61,152	18	48,941	15	40,476	32	86,162
GROUP 2 Blount, Cocke, Greene, Hamblen, Jefferson, Knox, Loudon, McMinn, Monroe, Sevier, Sullivan, Washington.	13	314,596	32	788,560	21	507,522	12	297,408	22	541,540
GROUP 3 Anderson, Bradley, Campbell, Claiborne, Grainger, Hamilton, Hancock, Hawkins, Meigs, Polk, Rhea, Roane, Union.	10	200,186	25	497,160	18	348,122	17	331,338	30	586,557
GROUP 4 Bledsoe, Cumberland, Fentress, Grundy, Morgan, Scott, Sequatchie, Van Buren.	6	35,524	24	133,697	12	70,631	16	89,140	42	238,816
GROUP 5 Clay, Coffee, Franklin, Marion, Overton, Pickett, Putnam, Warren, White.	12	175,860	29	434,186	17	263,476	13	198,091	29	435,756
GROUP 6 Macon, Montgomery, Robertson.	15	116,918	33	255,395	20	151,565	15	113,163	17	127,061
GROUP 7 Benton, Cheatham, Decatur, Dickson, Hardin, Hickman, Houston, Humphreys, Lawrence, Lewis, Perry, Stewart, Wayne.	10	216,919	21	481,259	14	299,967	16	352,610	39	863,183
GROUP 8 Bedford, Cannon, Davidson, DeKalb, Giles, Jackson, Lincoln, Marshall, Maury, Moore, Rutherford, Smith, Sumner, Trousdale, Williamson, Wilson.	21	797,664	32	1,235,746	15	598,201	22	872,987	10	380,000
GROUP 9 Carroll, Chester, Hardeman, Henderson, Henry, McNairy.	11	172,313	24	377,482	16	251,451	26	419,726	23	373,963
GROUP 10 Crockett, Fayette, Gibson, Haywood, Lauderdale, Madison, Shelby, Tipton, Weakley.	24	537,626	38	869,007	13	283,715	16	351,310	9	212,314
GROUP 11 Dyer, Lake, Obion.	41	217,273	33	174,489	11	57,176	7	38,043	8	44,412
Total	16	2,820,294	29	5,308,133	16	2,880,767	17	3,104,292	22	3,889,764

REPORTS BY DEPARTMENTS

AGRONOMY

H. P. Ogden

WEATHER

The year 1935 began with winter crops in excellent condition. January and February temperatures and rainfall were above normal. Eight inches of snow covered the ground during the only cold weather of this period, and crops were therefore looking exceptionally well when spring began.

March and April were warm and very rainy. This greatly hampered farming operations and was decidedly injurious to all grain crops except the few seedings of spring oats made in February. These made unusually high yields.

The weather in May, June, and July was ideal, and cultivated crops were in excellent condition until late summer.

From August 1 to October 15 it was very hot and dry. August 7 was the hottest August day ever recorded at Knoxville. September of this year was the driest on record, with only 10 per cent of the normal precipitation. Late summer and early fall seedings failed to germinate or were greatly delayed in germination.

From October 15 to December 15, rainfall and temperature were above normal, and conditions were ideal for late-seeded crops and fall plowing. After that, conditions were very bad. December 20 was within 4 degrees of the all-time low temperature record for December. Crops were in poor condition at the close of the year.

SMALL GRAINS

Wheat yields were below normal, except the varieties or strains selected for resistance to scab. All varieties came through the winter remarkably well, but the excessive moisture and warm weather of late spring resulted in considerable damage from scab.

Winter oats yielded well. Selections made by the Botany Department of the Station from the winter-type Fulghums were the best varieties tested. Seed of these selections will be increased for more extensive trials at the substations.

The season was very favorable to spring oats, and all varieties made good yields. Among the new varieties, Trojan made the best showing.

Balbo rye appears to be the best variety of rye for Tennessee. It has been released to farmers, who are being encouraged to increase the seed as rapidly as possible.

WINTER PEA BREEDING

For several years efforts have been made to develop a winter-hardy disease-resistant strain of winter pea (Pisum) to be used as a winter cover and green-manure crop. During the year 1935 this work consisted largely in the testing of progeny of crosses between Austrian winter pea and disease-resistant garden or canning peas

and also in the testing of material for additional crosses. The problem was narrowed down to a search for a strain of peas resistant to Ascochyta blight (*Mycosphaerella pinodes*). Strains of peas have been secured from different plant breeders and through the Office of Foreign Plant Introductions, but nothing has been found resistant to this disease. There is little hope for progress along this line till such a strain can be found and used in crosses.

SOYBEANS

Tests of new strains of soybeans were continued in single-row plots as in the past. The better strains from previous tests, as well as new strains received each year from the Division of Forage Crops and Diseases, U. S. Department of Agriculture, were included in the test. Yields of hay and seed were obtained and records kept of various features which might aid in identification of the variety or would affect its value for seed or hay, such as size of seed, color and soundness of seed, coarseness of stems, habits of growth, number and placement of branches, tendency to lodge, tendency of seeds to shatter, and earliness.

While many new strains have been received and tried, none has yet been found markedly superior to Tokio for both hay and seed. Some of the new strains are less inclined to shatter and are a little earlier, or possibly better suited for seed production, but further trial is needed before any can be recommended to replace Tokio and the other varieties being grown in Tennessee.

VEGETABLE VARIETIES OF SOYBEANS

Tests with "Green vegetable" varieties started in 1933 with 91 strains were continued in 1935 with only 32 strains. These were compared as to yield, date of maturity, and palatability. Yields were obtained on the mature beans and not on the green beans. Dates of maturity were obtained at both the green stage when cooked and at the mature stage. Palatability was tested by canning the green shelled beans seasoned only with salt and submitting them later, all at one time, to a committee of judges.

The cooking tests were made in cooperation with Miss Blanche Tansil, who was at that time with the Tennessee Valley Authority. Each variety was canned when it was believed to be in the best stage for cooking. All varieties were later opened and judged as to flavor, appearance, etc., by judges selected from the School of Home Economics of The University of Tennessee, the Industry Division of the Tennessee Valley Authority, the Tennessee Agricultural Exprirment Station, and others. While the judges were not experienced in judging cooked soybeans and not always in harmony in scoring or placing varieties, there was sufficient agreement to warrant the conclusion that all strains are palatable as green vegetable and also that some strains are more desirable than others.

The high food value of green soybeans would seem to warrant further testing and the multiplication of seed of the more desirable strains.

SOYBEANS SEEDED IN SMALL GRAIN

For some years soybeans have been seeded on winter oats in late March, the grain drill being set to sow shallow. Tokio and Laredo have been used in this test. Both varieties make some growth before the oats are harvested, but only Tokio makes enough growth to interfere with cutting. Laredo germinates better and interferes less with the oats. Both varieties are injured slightly when the oats are cut. The injury is less in the case of Laredo. The amount of injury also depends on the height at which the oats are cut.

The practice of seeding soybeans in winter oats has three advantages: It gives good yields of soybean hay; keeps the soil occupied with a growing crop during the time of year when torrential rains sometimes occur, thus reducing soil erosion; and eliminates the cost of an extra plowing and seed-bed preparation.

It should be understood, however, that the experiments mentioned above were conducted on fertile soil in years of good April and May rainfall. This practice has not been tested on poor soil nor in years of low April and May rainfall.

LESPEDEZAS

Experiments to determine the effect on seed yields of cutting lespedeza for hay at different stages of maturity were continued. Several years will be required for this test, since results vary with the season, soil fertility, and other factors that affect the kind of growth made by the lespedeza. In general, cutting for hay after plants are out of bloom and before seed mature often prevents ripening seed except on poor land where growth is so short that seeds are formed below the level of the mower cutter bar. On fertile soil, cutting for hay two or three weeks before first blossoms appear usually increases seed yields over uncut plots. The quality of the hay is also superior, but the yields are decidedly less. Cutting when in full-bloom or a little later gives good yields of hay and usually sufficient seed for reseeding but not enough seed for harvesting. Reseeding is less certain on rich soil where growth is dense and tall, causing excessive shedding of lower leaves.

Sericea seedings on winter grains were continued. In these experiments, 25 pounds per acre of unscarified seed sown in a grain crop in January or early February, or 17½ pounds of scarified seed sown in March or early April, gave excellent stands of sericea with the minimum interference from weeds. June seedings on clean land and no nurse crop were also good.

Sericea seeded with spring oats made better stands, larger yields, and a better quality of hay than sericea seeded at the same dates without spring oats. These trials were made, however, on fertile soil, badly infested with weed seed, and the season was rainy. On poor soil and in a dry season, better results are obtained by sowing sericea alone.

Hop clover, *Trifolium procumbens*, was seeded at the rate of 8 pounds per acre on sericea stubble after the cutting of a heavy seed

crop of sericea. In spite of a thick mat of sericea leaves, a good stand of hop clover was secured. In the spring of 1935 the hop clover made such a dense growth that the sericea stand was decidedly reduced and the injurious effect on the sericea was noted throughout the season of 1935.

CORN AND SORGHUM

Varietal and cultural experiments with sorghum and corn were continued, with few changes, as in the past.

FERTILIZER EXPERIMENTS AND CROP ROTATIONS

A decided change was made in the cowpea-wheat rotation. The experiment was begun in 1905 with cowpeas grown each summer and wheat each winter. Various phosphate carriers, in combination with potash and manure, had been used and effects of removing the hay or of turning it under studied.

The change made in 1935 was the substitution of Korean lespedeza for cowpeas. Farmers of the State are adopting the practice of growing lespedeza in the summer, followed by wheat in the winter. It is therefore important to determine the relation of such a cropping system to the problem of soil fertility.

Extensive fertilizer experiments were carried on in cooperation with the Tennessee Valley Authority on 18 farms in Knox and nearby counties. In these experiments, comparisons were made between various phosphate carriers in combination with different carriers of nitrogen and potash. The fertilizer combinations were applied alone and also supplemented with calcium silicate slag, or gypsum. The crops used were chiefly corn, potatoes, and soybeans, although cowpeas, flax, crimson clover, barley, and wheat were also used.

Results of the experiments indicate profitable crop increases from the use of phosphate. The differences between results from common superphosphate, triple superphosphate, and dicalcium phosphate were not marked. Fertilizer combinations supplemented with either granular or ground calcium silicate slag were not significantly different in results from the same combinations not supplemented. There was some indication of a depression of yields where slag was added.

The effects of different forms of nitrogen on the various phosphate carriers was not marked, but differences were noted.

CORN BREEDING

L. S. Mayer

The work of corn improvement is being continued along the lines indicated in previous reports. This is a brief summary of the work of 1934 and 1935.

TOP CROSS YIELD TEST

In attempting to determine the value of self-pollinated lines of corn, the method heretofore has been to re-combine these inbreds in as many single crosses as possible and then test these crosses for

yield. This has been a long, laborious process, with much of the work futile because of poor crosses.

The more recent method is to determine first the value of the various inbred lines by top-crossing them with the open-pollinated variety from which the inbred lines have been produced. This top-crossing method consists in detasseling all the inbreds, permitting them to be pollinated with the open-fertilized variety. The top-crossed inbreds are then tested for yield against the parent variety. A rapid elimination can be made of the poorer inbred lines and only the very best retained for subsequent hybridizing.

In 1935, the first yield test of Neal Paymaster top-crossed selfed lines was made. This test included 230 lines checked with the open-fertilized Neal Paymaster parent variety. The average yield of shelled corn per acre of all the checks was 28.5 bushels, with a shelling per cent of 85.00 and a dry-matter per cent of 89.32, indicating a field of about average productivity for the State. As a result of this first test it was possible to begin eliminating the poorer lines, but only those lines which were poorer than the check by 25 per cent in yield were dropped. Several lines were added which had not been included in the 1934 test because of lack of seed. In all, 25 lines were discarded and 205 were retained for testing in 1935.

The second year test was planted on the U. S. Cotton Field Station farm recently acquired a short distance outside the city. The badly run-down, poor condition of this farm was unfortunate, but no other land was available for the yield test. The results, as expected, were very uneven. Nevertheless, by combining the two-year yields it was possible to make many more eliminations of unsatisfactory lines. Of the 205 Neal Paymaster lines tested in 1935, 93 have been retained for a third test and 112 have been discarded. Some of these better lines have already been used in single crosses and will be further recombined in double crosses for testing fully in 1937.

DOUBLE CROSSES

Fifty-five double crosses of Neal Paymaster selfed lines were tested in 1935. Of these, 25 have been discarded because of low yield. In general these double crosses have included one or more lines that have been eliminated because of their poor performance in the top crosses. The remaining double crosses have been retained to be further tested in 1936. In some cases substitutions of one or two lines are being made. Six of these double crosses have shown yields of 20% or more over the parent Neal Paymaster and in each case the four selfed lines involved are among the outstanding performers in the top-cross tests.

HYBRID SEED

The question of hybrid seed corn and its use is coming more to the fore each year. The corn-improvement program at the Station includes the production of hybrid seed. It should be borne in mind that the highly publicized hybrid seed from the corn belt or elsewhere outside the State may not be any more valuable to the South than

the parent varieties have been. Work is going on here to produce hybrids from such standard Tennessee varieties as have been recommended by the Station, and when such hybrids prove their usefulness, steps will be taken for their commercial production. Neal Paymaster and Jarvis Golden Prolific are the two Tennessee recommended varieties already being worked with, and others will be added as rapidly as possible.

Plans have been made to include in the varietal test of 1936 many of the corn-belt commercial hybrids for data on their yielding ability under Tennessee conditions.

JARVIS GOLDEN PROLIFIC

The first year's test of Jarvis top-crosses was made in 1935. This test included 31 selfed lines. On the basis of a 50-bushel average yield of 3 commercial strains of Jarvis Golden Prolific, only 10 of the top-crossed Jarvis lines were better than the checks, though 5 others were within one-bushel difference in yield. Sixteen lines are being retained for a further yield test in 1936. Other selfed lines of Jarvis will be begun also.

VARIETAL YIELD TEST

In 1934, 26 white and 6 yellow strains were tested. Using the yield of Neal Paymaster seed from the originator as a check, 12 of the white entries were above the check and 13 below. Five of these superior ones were Station crosses and top-crosses. One other was a double cross from the U. S. D. A. Jellicorse Twin Ear, from the West Tennessee Station, gave 16 per cent increase. Three Neal Paymaster strains, the only ones tested in addition to the check, also ranked high. The miscellaneous white varieties sent in by growers in the State and the commercial varieties of professional seedsmen, with one exception, were below the check in yield. Two Jarvis single crosses of the Station and one hybrid yellow from a Tennessee grower were among the best of the yellows.

In 1935 the check variety of W. H. Neal topped all the entries, with 62.7 bushels of shelled corn per acre. The average yield of all 4 Paymaster strains was 60.9 bushels. Jellicorse from the West Tennessee Station and a Delta-Paymaster cross gave 59 bushels, while Hickory King was lowest, with 48.7 bushels. Among the yellow varieties a commercial hybrid from Virginia headed the list, with 55.7 bushels; a Station Jarvis cross coming next, with 55.3 bushels.

A YELLOW NEAL PAYMASTER

A previous report noted the beginning of an attempt to produce a hybrid variety between Paymaster and Jarvis that might give a commercial yellow variety similar to Paymaster and capable of giving as high a yield as that variety. The Jarvis variety has been top-crossed two years by Neal Paymaster. The strain will be top-crossed again in 1936 and then be followed by two or more selfing years. A method of open fertilization and selection will also be attempted in 1936 in order to hasten results, if possible. The results so far attained look very promising indeed.

BOTANY

N. I. Hancock

The loss of the head of the Botany Department, Mr. S. H. Essary, occurred in the spring of 1935. After his death the tomato and red clover projects were transferred to the departments of Plant Pathology and Horticulture, and are not included in this report.

Cotton

The cotton program was extended somewhat, through the cooperation of the Division of Cotton and Other Fiber Crops and Diseases of the U. S. Bureau of Plant Industry. A cooperative breeding program was outlined for the new U. S. Cotton Field Station, which is located eight miles from the main Station. It is expected that these increased facilities will enable us to analyze more of the cotton problems.

Varietal trials were continued. Delfos 719 appeared to be the outstanding variety. This strain is a selection from the old Delfos 6102, but has few points of resemblance to the parent. It is 1-1/16-inch cotton and makes a vigorous plant. It is earlier-maturing, produces larger bolls, and has a higher lint percentage than Delfos 6102. It should be well adapted to the bottom lands in Tennessee. Acala 44-5-2118, Trice W-2-1, and Rowden 4046 are other new strains that ranked well in the tests. The Acala strain is a 1-inch cotton, while the Rowden and Trice strains are 15/16-inch. Stoneville 2A and D. P. L. 11 have supplanted the old parent strains. Stoneville 2A is somewhat earlier, while D. P. L. 11 has a higher lint percentage than the parents.

More selfed lines were begun this year. It is thought that if the method used upon corn is followed, the quality of lint may be improved by selection within inbred lines, and hybrid vigor may be restored when these lines are crossed. A large percentage of blooms shed naturally, so that many flowers must be selfed before a small seed supply is insured, and the method is a rather expensive one for cotton.

Searing the lobes of the stigma with a small electric wire reduced the locks of the boll by the number of lobes operated upon. Thus it was shown that the lobe has a very definite relation to the fertility of the seeds in its lock; so that in many cases 3- and 4-lock bolls may often be the result of injury to one of the lobes.

Cotton pollen studies were continued, in cooperation with G. A. Shuey, of the Chemistry Department. It was found that cotton pollen would germinate on artificial media, between pH9 and pH10, in a range of temperatures as low as from 48° F. to 53° F., and that optimum temperatures were from 73° F. to 83° F.

As many as 5400 individual bolls of Stoneville 2, Wilds 2, and Trice 84-50 were hand-ginned by students. This material has been catalogued and data have been recorded on blossom dates; days of maturity; node placement; lock, seed, and mote numbers; and weights of lint and seeds. These samples will be used for further studies on lint quality.

Oats

Ten of the most winter-hardy oat strains have been retained. In 1934-35, in the field trials conducted by the U. S. Bureau of Plant Industry, Division of Cereal Crops and Diseases, 090 ranked first. This strain also ranked first in the cold-chamber tests conducted by the same Division at Ames, Iowa. Four strains—090, 1884, 1945, and 1922—were placed in the varietal tests at Knoxville in 1934-35. Observations the past year indicate that these strains lodge worse than some of the other varieties and that they need improvement in this respect.

Barley

Strains saved from the hybrid No. 52 x Lions include 115 selections. This cross was made in 1930, and segregates from it appeared fairly homozygous this year. Winter-hardy types will be tested against the parent, No. 52, and Maryland Nobarb.

ANIMAL HUSBANDRY

M. Jacob

BEEF-CATTLE-FEEDING EXPERIMENTS

The steer-feeding experiment at the Knoxville Station, begun in 1933 to determine the influence on finishing 2-year-old steers when dicalcium phosphate ($CaHPO_4$) is added to a standard steer-feeding ration consisting of cottonseed meal and corn-and-sorghum silage, has been continued.

The plan of the experiment was the same as reported last year. The results this year were also slightly in favor of lot 2, in which the average gain per steer for the 150-day feeding period was 243.4 pounds as against 236.7 pounds for lot 1—a difference of 6.7 pounds in favor of the steers receiving dicalcium phosphate. The cost per 100-pound gain was also slightly in favor of the steers receiving dicalcium phosphate, being $11.16 for lot 2 and $11.61 for lot 1. This experiment will be continued in order that more definite conclusions may be drawn.

The steer-feeding-and-grazing experiment begun at the Middle Tennessee Station, Columbia, in 1929, to determine the amount of grain necessary to feed 2-year-old steers being finished on grass in order to produce the most economical gains and at the same time have sufficient finish to meet market requirements, was repeated this year for the fifth year. As during previous years, the cattle, consisting of medium-grade 2-year-old steers, were divided into 5 uniform lots of 5 steers each. All lots were on uniform pasture throughout the entire grazing period of 117 days from April 6 to August 1, 1935. Lot 1 received no grain and no dry roughage; lot 2 received 5 pounds of crushed corn-and-cob meal per steer per day in addition to pasture; lot 3 received 5 pounds of crushed corn-and-cob meal per steer per day and all the hay the steers would consume; lot 4 received 4 pounds of crushed corn-and-cob meal and 1 pound of cottonseed meal per steer per day; lot 5 received 10 pounds of crushed corn-and-cob meal per steer per day. The average daily gain per steer during the 117-

day grazing period was 1.291 pounds for lot 1; 1.505 for lot 2; 1.399 for lot 3; 1.577 for lot 4, and 1.675 for lot 5. The cost per cwt. gain during the grazing period was $4.21 for lot 1; $6.80 for lot 2; $6.98 for lot 3; $7.88 for lot 4, and $9.18 for lot 5. The average selling price was $8.03 per cwt. for lot 1; $8.50 for lot 2; $8.66 for lot 3; $8.33 for lot 4, and $9.00 for lot 5. The dressing percentage was 58.14 for lot 1; 59.07 for lot 2; 57.88 for lot 3; 58.23 for lot 4, and 59.59 for lot 5. Taking into consideration winter and summer feed costs and cost of marketing, the average profit per steer was $26.28 for lot 1; $23.47 for lot 2; $30.31 for lot 3; $24.93 for lot 4, and $30.57 for lot 5. This is the first year during the 5-year period the experiment has been underway that heavy grain feeding on pasture appeared more profitable than either no-grain or light-grain feeding under conditions as they existed at the Middle Tennessee Station. With one more year's work we should be justified in drawing definite conclusions from this experiment.

The beef-cattle-cost-of-production experiment at the Middle Tennessee Station is being continued. The first crop of calves out of the grade Shorthorn cows and sired by a registered Hereford bull are now on hand and will offer an opportunity to make a comparison with the calves of previous years out of the same dams but sired by registered Shorthorn bulls.

As a part of the beef-cattle-cost-of-production experiment, a baby-beef-feeding test was undertaken to determine:

1. The comparative values of shelled corn, ground shelled corn, and corn-cob-and-shuck meal in winter-finishing baby beeves.

2. Whether winter-finishing baby beeves was profitable under Tennessee conditions.

The test was undertaken this year with 3 lots of high-grade station-bred beef calves. Lot 1 was fed a grain mixture consisting of 1 part, by weight, of cottonseed meal and 3 parts, by weight, shelled corn; lot 2 was fed 1 part, by weight, of cottonseed meal and 3 parts, by weight, of ground shelled corn; lot 3 was fed 1 part, by weight, of cottonseed meal and 3 parts, by weight, of crushed-corn-cob-and-shuck meal. All lots were fed grain and alfalfa hay *ad libitum* and 8 pounds of silage per calf per day. They were fed from January 7 to May 1, 1935. The accompanying table gives some details of this test.

Data on baby-beef experiment

	Lot 1 Shelled corn and cottonseed meal	Lot 2 Ground shelled corn and cottonseed meal	Lot 3 Crushed corn-cob-shuck meal and cottonseed meal
Number of calves	4	4	4
Number of days on feed	113	113	113
Average initial weight (lbs.)	427.5	425	400
Average final weight (lbs.)	681.2	647.5	601.2
Average gain per calf (lbs.)	253.7	222.5	201.2
Average daily gain per calf (lbs.)	2.224	1.968	1.780
Cost per cwt. gain	$ 7.50	$ 8.94	$ 8.23
Average selling price per cwt.	9.54	9.67	9.17
Net profit per calf	25.39	22.22	19.37

Lot 1 gave the most favorable results, although all 3 lots showed a substantial profit. Under conditions as they existed this year, finishing beef calves as baby beeves by the time they were 12 to 16 months old was profitable. This experiment will also be continued.

The baby-beef-feeding-and-grazing experiment begun in 1933 at the West Tennessee Station, located at Jackson, is still under way. The second crop of calves are now being used. The object of the experiment is to determine the amount of grain necessary for most economical finishing of baby-beeves, with free access to winter, spring and summer pasture. The calves used in each lot were high-grade Aberdeen-Angus and very uniform, but it was necessary to have a slight variation in numbers. The plan of feeding, grazing, and managing these calves was the same as last year and is given in the Annual Report for 1934. The table reveals some information on the results for this year.

Data on baby-beef-feeding-and-grazing experiment

	Lot 1 No grain	Lot 2 Grain in Winter	Lot 3 Grain in winter and summer
Number of calves	6	5	6
Days on pasture Nov. 5, 1934—July 2, 1935	181	181	181
Average initial weight per calf (lbs.)	381	366	381
Average final weight per calf (lbs.)	629	669	724
Average gain per calf (lbs.)	248	303	343
Average daily gain per calf (lbs.)	1.03	1.26	1.47
Total feed cost	$ 17.47	$ 27.95	$ 33.23
Cost per cwt. gain	7.05	9.23	9.69
Necessary selling price per cwt. to break even—July 2, 1935	5.20	6.36	6.66

As during the previous year, there was considerable difference in the condition of the 3 lots at the end of the winter feeding and grazing period. Lot 3 carried the most finish and lot 1 the least. During the summer period lot 2 made the poorest gains. This work must and will be continued for conclusive results.

LAMB STUDIES

This was the first year of an experiment being conducted at the Middle Tennessee Station, in cooperation with the U. S. Bureau of Animal Industry, to determine the value of feeding grain to breeding ewes in the production of early spring lambs. This experiment involved the use of 4 uniform lots of ewes and their lambs and was begun in the fall of 1934 after the ewes had been bred and was then carried out as follows:

Lot 1.—The ewes in this lot and their lambs were grazed without grain during the entire experimental period, until the lambs acquired desirable market weights in the spring of 1935.

Lot 2.—The ewes in this lot were handled and grazed without grain similarly to lot 1, but the lambs were fed grain in creeps until the end of the experimental period. The grain mixture consisted of 3 parts, by weight, of cracked shelled corn, 2 of oats, and 1 of bran, which was fed *ad libitum*.

Lot 3.—The ewes in this lot were fed ½ pound of a similar grain mixture per ewe per day from November 1, 1934, until 3 days after the lambs were born, when the grain ration was increased to 1 pound per ewe per day, being continued at this rate until the end of the experimental period. The lambs in this lot did not receive grain.

Lot 4.—The ewes in this lot were fed grain the same as in lot 3, but the lambs were also fed grain in creeps as were those in lot 2. All lots had access to uniform pasture, consisting of permanent pasture of bluegrass and orchard grass for the late summer and fall, rye and crimson clover or barley during the winter, and blue grass and white and hop clover during the spring and early summer. The 4 lots were rotated every 2 weeks. The lambs, consisting of 96 head, were shipped to the U. S. Experiment Farm, Beltsville, Maryland, during the first week in June, 1935, for slaughter and carcass grading. The results for this year are shown in the following tables.

Weights and gains of spring lambs, 1935

	Lot 1 Ewes—no grain Lambs—no grain	Lot 2 Ewes—no grain Lambs—grain	Lot 3 Ewes—grain Lambs—no grain	Lot 4 Ewes—grain Lambs—grain
Number of lambs	21	25	24	26
Average birth weight of lambs (lbs.)	9.14	9.51	9.16	9.06
Average final weight of lambs (lbs.)	86.2	88.2	83.9	85.3
Average gain per lamb (lbs.)	77.09	78.6	74.7	76.3
Grain consumed per cwt. gain by ewes and lambs (lbs.)	None	42.6	199.9	239.4

Slaughter and carcass grades of spring lambs, 1935

	Prime	Choice	Good	Medium	Common	Cull	Average
Slaughter grade							
Lot 1 (21 lambs)		7	13	1			High Good
Lot 2 (25 lambs)		8	15	2			High Good
Lot 3 (24 lambs)		4	17	3			Good
Lot 4 (26 lambs)		12	12	2			High Good
Carcass grade							
Lot 1 (21 lambs)	1	13	7				Low Choice
Lot 2 (25 lambs)		14	10	1			Low Choice
Lot 3 (24 lambs)		9	14	1			High Good
Lot 4 (26 lambs)		15	8	3			High Good

The results this year were slightly in favor of lot 1, in which the ewes and lambs did not receive grain. This experiment has an important bearing on the sheep industry in Tennessee and will be continued until definite conclusions may be drawn.

DAIRY-CATTLE-FEEDING-AND-GRAZING EXPERIMENTS

The present status of the experiment begun at the West Tennessee Station in 1932 to determine the amount of grain necessary for most economical milk production when cows have access to all-year pasture, is referred to in the report for the West Tennessee Station.

The dairy-cattle-feeding-and-grazing experiment being conducted at the Middle Tennessee Station, in which the cows of one lot receive a half-grain ration and those of the other lot a full-grain ration, is now in its second year. While the results up to this time would not justify drawing definite conclusions, they are, nevertheless, favorable for a limited grain ration under conditions as they occurred during the past 2 years at the Middle Tennessee Station.

BANG'S-DISEASE CONTROL

In the conduct of work for the control of Bang's disease in the breeding herds at the Middle and West Tennessee Stations, agglutination tests are still being made every 90 days by both the Huddleson and tube methods. While not a single abortion has occurred in the Jersey herd at the West Tennessee Station since the herd was established in 1926, the test in April of this year revealed 2 reactors and 4 suspects. If the 2 cattle which were positive on 4 dilutions by the Huddleson method and on 2 dilutions by the tube method are definitely infected with *Brucella abortus* the source of infection has not yet been determined. This situation up to the present time, while apparently not serious from the standpoint of actual abortions, provides an interesting problem for further study.

The breeding herd at the Middle Tennessee Station, consisting of 97 head, on the April test revealed 1 reactor that was positive in 3 dilutions by both the Huddleson and tube methods, and 4 that were suspicious as indicated by positive reactions in 2 dilutions by both methods. Ninety-two were negative in all dilutions by both methods. Since the established program for Bang's-disease control has been carried out in this herd, practically maximum breeding efficiency has been maintained.

As for several years past, the fine cooperation of Mr. L. R. Neel, Superintendent of the Middle Tennessee Station, Mr. Ben P. Hazlewood, Superintendent of the West Tennessee Station, and Professor H. R. Duncan of Knoxville has been most helpful in the development of a constructive livestock research program.

CHEMISTRY

SOILS AND FERTILIZERS

W. H. MacIntire

In addition to the regular analytical work upon the leachings of the several lysimeter investigations, considerable time has been devoted to the study of the residual properties of certain of the soils in the older lysimeter units, with particular reference to residues of absorbed calcium and magnesium that had been incorporated as oxides and carbonates 21 years previously. Progress has been made on a correlated laboratory study of potash sorption in relation to calcium and magnesium, as supplemental to the lysimeter experiments. A number of soils were analyzed to determine the fate of barium added as barium silicofluoride and the inactivation of soil sulfur as reflected by decreased sulfate outgo, the results being incorporated in Station

Bulletin No. 155. It was found that the added barium became fixed tenaciously and that the added fluorine was eventually present as calcium fluoride. Limestone was found to repress the outgo of fluoride, whereas dolomite had the opposite effect. In carrying out this work it was essential to develop an analytical technic that would effect complete removal of exchangeable bases and carbonates without attack upon mineral components. This necessary technic was developed and described in a contribution that appeared in Soil Science.

The calcium and magnesium silication project, comprising 44 units and involving 7 liming materials at 3 rates, with and without underlying strata of subsoil, was continued. At the beginning of the twenty-second annual period the surface soils were removed, screened, and mixed to assure uniformity of sampling, and then returned to the respective containers. This manipulation would be expected to show a stimulating effect on the microbiological activities and concomitant increase in outgo of calcium, magnesium, sulfates, and nitrates. The nitrate outgo, however, remained at the usual level of 20-25 pounds of nitrogen per acre, and although the calcium and magnesium outgo was somewhat larger than in the preceding year, the enhancement in outgo was within the limits of annual fluctuations for variations in seasonal precipitations. Samples of the surface soils have been reserved for a detailed study of the content of carbonates, sorbed calcium and magnesium, as influenced by variations in form of added liming materials and at different rates of treatment.

The study on the conservation of calcium and magnesium from equivalent moderate additions of 4 liming materials, as influenced by rate, depth, and sequence of incorporation, has been continued to show the residual effects of the treatments that were made in single and divided additions and replications during an 8-year period. The results of the first 8-year period appeared in Station Bulletin No. 152, simultaneously with identical publication by the Virginia Agricultural Experiment Station. Additional data have now been compiled for the 2-year period subsequent to the cessation of all treatments.

The study of rainwater solubilities of calcic and magnesic materials incorporated in quartz sand was terminated after 4 years' duration. This adjunct study was made to supplement and clarify some of the previously obtained data and to throw some light upon the activities of liming materials in the absence of fixation, a condition approached in the case of very sandy soils. Samples from the units that received additions of magnesic materials have been reserved for a study of the effect that exposure exerted upon hydration and carbonation of the oxides and carbonates of magnesium in the media where sorption was a nugatory factor. The results of this experiment will be available for publication in the near future.

The lime-potash-sulfate project, which was modified in 1929, completed its sixth year in the fall of 1935. In this experiment, 200-pound additions of K_2O have been made annually to each of 3 types of soils, with and without initial liming treatments. During the

past year the Jackson soil retained 74, 88, and 80-pounds K_2O as averages for the 3 conditions, no-lime, limestone- and dolomite-treated units, respectively. For the Crossville soil the repressions in outgo of K were equivalent to fixations of 95, 128, and 131 pounds of K_2O for the respective groups. For the Cumberland clay loam these values were 75, 97, and 95 pounds, respectively. The sulfate outgo from the K_2SO_4 additions was sufficient to account for the additions plus the sulfate outgo from the control soil, and hence sulfate outgo was not repressed by liming. The additions of liming materials induced an increase in the sulfate outgo in the early leachings, whereas the sulfate outgo from the unlimed soil was less initially and more sustained throughout the year.

When corrected for the controls, the nitrate outgo from the potassium nitrate additions was within 8 pounds of complete recovery and was unaffected by the liming of either of the several soils.

An interchange of bases was indicated by increased calcium outgo from the potassium-treated soils. The increase in calcium outgo was 94 pounds $CaCO_3$-equivalent from the Jackson soil, 68 pounds from the Crossville soil, and 57 pounds from the Cumberland clay loam. The smaller quantities of exchangeable magnesium in the several soils, as compared with exchangeable calcium, were reflected by the fact that the outgo of magnesium was not appreciably affected by potassium additions.

The effect of heavy additions of calcium, in the caustic form of CaO, upon the sorbed potash as measured by potassium outgo from a built-up supply was observed after a preliminary 800-pound treatment of K_2O as K_2SO_4. The 5 soils used in this experiment exhibit great variation in their sorptive capacities, not alone for potassium, but for sulfates also. Both the Chickamauga loam and the Cherokee clay subsoil have fixed 100 per cent of the added potassium. The Jackson silt loam retained 90 per cent, the Sevierville shale 85 per cent, and the Crossville soil 77 per cent of the added potassium. The Jackson and Chickamauga soils both permitted some of the rainfall sulfur to pass through, since the leachings contained about 100 pounds of SO_3 per acre in excess of that added as K_2SO_4. The Crossville soil yielded about 95 per cent of the added SO_3; the Sevierville, 68 per cent; and the Cherokee subsoil, only about 6 per cent of the addition. The annual leachings also removed variant quantities of calcium and magnesium from these soils. The $CaCO_3$-equivalence of the calcium and magnesium leached from the Chickamauga soil was 2400 pounds; that from the Jackson soil was 1600 pounds; whereas the Crossville and Sevierville soils both yielded about 800 pounds. The Cherokee subsoil yielded the minimal quantity of 100 pounds, which amount is appreciably less than the quantity usually obtained from the rainwater blanks. A second addition of 800 pounds of K_2O, as K_2SO_4, was made to the several soils at the beginning of the second year.

The related study of potassium fixation, as an effect induced by residues of lime and magnesium, was continued with an annual

application of 200 pounds of K_2O, as K_2SO_4. A recovery of approximately 100 per cent of the annual treatment was obtained from the unlimed soil and from the more acidic sulfur-treated units, and a distinct reversal of initial effects was noted when a like result was registered by the 32-ton CaO-equivalence of MgO. On the other hand, the residues from the light treatments of CaO and MgO and also those from the heavy treatments of CaO still continued to impart to the soil a capacity to effect an increased fixation of added potassium. The sulfate-outgo continued to be less than the amount of SO_4 added when compared with increments of rainfall sulfates and those attributable to sulfofication in the controls. A paper based on the results obtained in this study of the effects of residues of liming materials upon potassium outgo was given at the fall meeting of the American Society of Agronomy and will appear in an early 1936 number of the Journal of that Society.

The lime-phosphate experiment, which includes the P_2O_5 transitions induced by prior admixtures and soil mixtures of phosphates with limestone and with dolomite, was continued by an additional annual phosphate treatment of 96 pounds P_2O_5-equivalence to 3 types of soil. For the first time, an outgo of about 3 pounds P_2O_5 was obtained from the Jackson soil that had been limed prior to treatment with mono-calcium phosphate. The Cumberland and Crossville soils again yielded only meager quantities of P_2O_5, about .1 pound per acre in the leachings.

The lysimeter study on the conservation of sulfate sulfur added in the forms of $CaSO_4$, $MgSO_4$, and K_2SO_4, as affected by limestone and dolomite treatments, was continued. Complete recovery of the sulfates added with supplements of limestone and dolomite appears to be the rule. The higher recoveries from no-lime treatments for the year may be attributed to residues of sulfate from previous annual treatments. The double rate of K_2SO_4, equivalent to 800 pounds of $CaSO_4$, yielded the equivalent of 811 pounds of $CaSO_4$ in excess of the amount leached from the untreated control. The additions of K_2SO_4 and the $MgSO_4$ effected some base exchange, as indicated by an enhancement of 90 pounds $CaCO_3$-equivalence in the outgo of calcium.

The Chemistry-Agronomy experiment on the leachability of various nitrogenous materials was continued with one 33 pound nitrogen surface application in January. For the period between January, 1934, and January, 1935, the results show great diversity in nitrogen recoveries from various materials. In general, the recoveries from the Jackson soil were greater than those from the Cumberland loam, except for sodium nitrate, the recovery of which was complete in every instance. In the case of the Jackson soil, the annual recovery of nitrogen from additions of ammonium sulfate was 70 per cent for the limed soils and 73 per cent for the unlimed soils; from urea, 54 and 38 per cent, respectively; from Ammo-Phos, 82 and 50 per cent; from cottonseed meal, 47 and 80 per cent; from cyanamid, 51 and 46 per cent. Expressed as percentage of nitrogen applied, and with

correction for the nitrogen outgo from the controls, the recoveries from the limed and unlimed units of the Cumberland soil were as follows: Ammonium sulfate, 45 and 57; urea, 32 and 62; Ammo-Phos, 50 and 5; cottonseed meal, 17 and 17; and for cyanamid, 42, and 36. With the exception of sodium nitrate, which showed practically complete recovery in the early spring leachings, the nitrogen removal by the rainwater from the treatments was very gradual throughout the season. In the early spring leachings, ammonia and nitrate forms of nitrogen have been found in very small quantities, varying between small fractions of a pound to one pound per acre.

The second phase of the study of outgo of nitrogen as affected by subsoil was begun in January, 1934, in parallel with the previous study relative to the behavior of different nitrates. Triplicate treatments of equivalent quantities of ammonium chloride, ammonium phosphate, and ammonium sulfate were applied to surface soil underlaid by 5 feet of red clay subsoil. In the previous completed study of nitrates a heavy rate, equivalent to 6,000 pounds of $NaNO_3$ per acre, was used to determine the effect of the subsoil on the retention of the nitrate nitrogen. The new study was planned to develop the parallel between the behavior of ammoniacal salts and nitrates in the same soil and a 5-foot depth of subsoil. The results for the first year registered no advent of nitrogen in the leachings. The results for the second year indicate a heavy outgo of nitrogen as ammonia and as nitrates.

The lysimeter experiment on the behavior of 7 ammoniacal carriers on 3 types of Tennessee soils was continued with a 33 pound per acre nitrogen addition. The total recoveries of nitrogen may be best compared when reckoned from January to January, the period between annual treatments. During the 1934-35 period the nitrate nitrogen supplied as ammonium nitrate was washed out in the first leaching, which was collected on March 3 and without appearance of any significant quantities of either ammoniacal or nitrate forms. The succeeding leachings of March, April, and May, carried from 1 to 3 pounds of nitrogen leached from several of the treatments. But the total quantity of nitrogen leached from any of the ammoniacal treatments during the winter and spring was only a small fraction of the amount added. The largest nitrogen outgo occurred in the leachings that were sampled in October. When corrected for the nitrogen outgo from the respective untreated soils, the total nitrogen-outgo results for the annual period showed that none of the nitrogen added as either mono- or di-ammonium phosphate was removed by the rainwater leachings, whereas, the recoveries from the other forms of ammonia were, as an average, about 20 per cent of the addition, with approximately 50 per cent as the maximal. In the case of the Cumberland and the Crossville soils, nitrification of the several ammoniates appeared to be slow. This was not true, however, of the Jackson soil.

The comparison of the behavior of the three types of lysimeters was continued, decided differences being found for the volumes of the leachings and their content of Ca, Mg, and nitrates.

The chemistry of phosphates was studied in collaboration with the TVA. Two papers dealing with analytical technic adapted to the analysis of raw and processed phosphate rock were presented at the November, 1934, meeting of the A. O. A. C. and these papers were published in the late 1935 issues of the Journal of that Association. It was demonstrated that widely variant results are obtained when the optimal analytical conditions are not imposed. In this connection it was determined that the mere inclusion of a suspension, either a dispersed filter paper or asbestos, materially increased the solubilities indicated by ammonium citrate digestions.

In the study of processes for making phosphates, two methods of production were developed. One was for the making of a type of triple superphosphate which is substantially a mono-maganese phosphate. This product was developed for the treatment of rhodochrosite with 85 per cent H_3PO_4 under conditions that would effect optimal reaction, together with a supplemental treatment with either ammonium or limestone to assure good mechanical condition of the otherwise hygroscopic product. The second process was for the making of a true tri-calcium phosphate monohydrate, by inducing reaction between concentrated H_3PO_4 and a centrifuged solution of lime in sucrose. Chemical and X-ray analyses of the product thus obtained proved that the material is $Ca_3(PO_4)_2.H_2O$.

Two collaborative studies also dealt with the "cutting" of triple superphosphates to "standard" concentration. The chemical properties of the calcium silicate "slag" from the pyrolytic production of phosphoric acid were determined. Two forms of the calcium silicate slag, the ground air-cooled product and the quenched material, were used in lieu of limestone in both dry and wetted mixtures with triple superphosphates of calcium and ammonium. No deleterious effects were noted in the dry mixtures, which converted about 30 per cent of water soluble P_2O_5 to di-phosphate. No loss of ammonium and no potash fixation were encountered in the dry mixtures of complete mixtures. A distinct decrease in "availability" of P_2O_5 occurred, however, when the wetted mixtures were aged. This was attributed to the formation of the apatite molecule, $3Ca_3(PO_4)_2.CaF_2$, for which conclusion there was supporting X-ray evidence. The results have been reduced to manuscript and the paper has been accepted for publication in *Industrial and Engineering Chemistry*.

A detailed study of the chemical changes and physical effects that result from admixtures of limestone and dolomite with triple superphosphate was also conducted both in closed systems in the laboratory and in piles up to 9 tons. In determining the speed and extent of diphosphate transitions the innovation of pre-wetting the limestone and dolomite was tried, to expedite reaction and to increase the amount of available magnesia in the phosphatic mixtures with dolomite. The wetted mixtures quickly attained equilibria, with diphosphate transitions up to 90 per cent of the possible amounts, and with a very dry condition as a chemical effect of change of moisture to water of hydration. With re-working by hand, or by

re-mixing in concrete mixers and curing in unconfined piles and restriction in size of piles, the danger of set-up was obviated. The results have been prepared for publication in *Industrial and Engineering Chemistry*.

During the summer of 1935 a TVA laboratory was fitted up in Temple Hall, with especial equipment for the carrying out of Neubauer studies as supplemental to direct chemical studies of new types of phosphatic fertilizers that are being evolved by TVA and also for carrying out chemical tests such as those developed at the Indiana Station. By arrangement between that Station and TVA the part-time service of Dr. S. F. Thornton was available for the inauguration of this work and related pot studies to be conducted in an adjacent TVA greenhouse, the construction of which was begun in November, 1935.

The Associate Soil Chemist again served the A. O. A. C. as Associate Referee for liming materials, and he also collaborated in studies that lead to the adoption of a method for the determination of the iodine content of soils. The Associate Chemist served the same organization as its Associate Referee for Fluorine. The Chemist continued as General Referee for Soils and Liming Materials and as the A. O. A. C. designate on the Board of Governors of the Crop Protection Institute. It was also the privilege of the Chemist to give the fifth Wiley Memorial lecture at the 1935 meeting of the A. O. A. C.

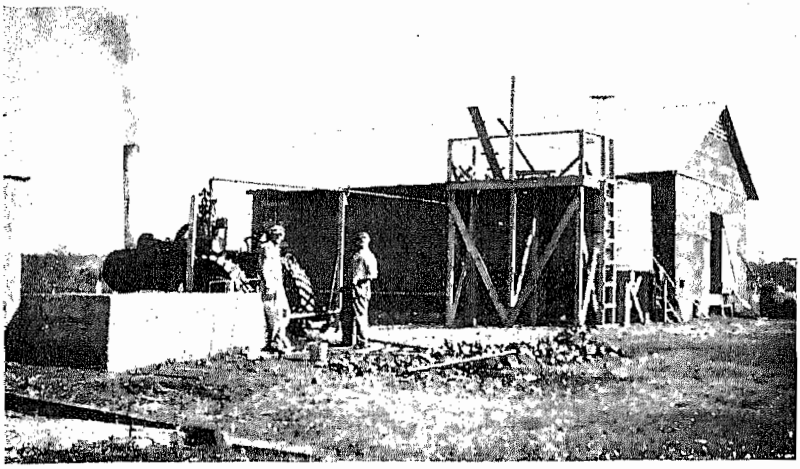
GENERAL

G. A. Shuey

The forty-seventh (1934) annual report included a brief discussion of the chemical phases of the fluorine spray residue problem. During the past year this work was continued. The question of fluorine and arsenic spray residues is brought to the attention of the grower and the consumer because of the present tolerance regulation for these elements. Cryolite is found to be a very effective substitute for arsenicals. Apples for spray residue studies were supplied by growers from 5 states. The apples had been sprayed with cryolite and later washed by several different methods. Thirty samples were analyzed, and the results show that when cryolite-sprayed apples are properly washed the residual fluorine falls within the tolerance limit, which is set at 0.01 grain per pound of fruit. Some effort is being expended in developing a more rapid method for the analysis of spray residues on fruits.

The natural fluorine contents of navy beans, soybeans, carrots, sweet potatoes, breakfast cereals, sorghum sirup, and numerous other articles of food have been determined. Numerous fluorine analyses have been made in connection with animal feeding experiments conducted jointly by the departments of Entomology and Home Economics.

During the year some attention was given to a study of sorghum sirups. In cooperation with the Tennessee Valley Authority, experiments were performed with the object of producing a better-quality



Experimental sorghum processing plant

sorghum sirup. It was found that a high-quality, non-crystallizing sorghum sirup can be made by a method which is, briefly, as follows: The raw juice, as it comes from the press, is evaporated to a semi-sirup and collected in a barrel or wooden tank. After cooling to about 140° F., the proper amount of invertase is added (invertase is available as a standardized product), and the whole allowed to stand for 12 hours, after which it is concentrated by evaporation to the desired density. Sirup prepared by the above method remained fairly clear and free from sugar crystals after standing for 6 months. This work is to be continued with the object of making a standardized sorghum sirup on the farm and on a community scale.

Investigations seeking new uses for various farm products, particularly by-products of fruits and vegetables, have been in progress. The utilization of strawberries in the making of juice and semi-sirup, discussed in last year's report, was continued. The Blakemore variety of strawberries produced a juice of richer flavor and somewhat deeper color than any other berry thus far studied. Dr. Florence L. MacLeod, of the Home Economics Department, conducted animal-feeding tests to determine the vitamin C content of strawberry juice, and found that it contains approximately 80 units of this vitamin per pound of juice. Comparing this result with those reported by Sherman ("Chemistry of Food and Nutrition," Chap. 19, pp. 427-8), Doctor MacLeod concludes that strawberry juice is equivalent to pineapple in vitamin C content, but is only about one-half as rich in fresh strawberries. She further states that strawberry juice as a source of vitamin C is only about one-third as rich as are oranges and tomatoes.

Blends of strawberry juice with apple cider, and with grape juice, have been considered. Also, the possibilities of developing fruit juice concentrates for home and commercial use are being studied.

Commercially dehydrated fruit products, such as raspberries, strawberries, and powdered apples, are being investigated with respect to their use in jelly-making.

A process developed at the Station for making dehydrated products out of sweet potatoes is being further studied. With the cooperation of the Tennessee Valley Authority, equipment for experimental dehydration studies is being designed.

The idea of using invert sugar in the quick freezing of fruits was conceived in the Station department of General Chemistry. This came about as the result of a request from the Agricultural Industries Division of the TVA for assistance in the matter of finding a better sugar solution than sucrose, which they had been using up to this time. Accordingly, studies were conducted, and recommendations were made, concerning the preparation and use of invert sugar as a medium for the quick freezing of fruits.

Silage samples were analyzed for the department of Animal Husbandry. As a matter of interest, the results of these analyses are given:

Analyses of silage samples

	Moisture	Ash	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Corn-sorghum Silage.....	72.87	6.75	5.73	1.73	48.97	36.82
Grass silage (concrete silo)	75.30	8.48	12.83	3.88	31.34	43.47
Grass silage (trench silo).	73.46	8.98	15.85	4.37	29.68	41.12

Percentages of ash, crude protein, ether extract, crude fiber, and nitrogen-free extract are given on the water-free basis.

Considerable analytical work, such as analyses of fertilizers, feeds, foods, and insecticides, has been done for the several departments of the Station. The calcium and phosphorus contents of blood taken from 24 head of experimental beef animals have been determined periodically during the year.

Studies on the preparation of media for germinating cotton pollen were continued. A complete report of this work is now in preparation.

Experiments in the laboratory have shown that a very high-quality vinegar can be made from sweet potato culls. The potatoes naturally contain an enzyme which becomes active when properly heated and converts much of the starch of the potato into maltose sugar. The sugar liquid, when subjected to controlled fermentation processes, results in the formation of a vinegar which is comparable to malt and apple cider vinegars. Further experiments are being planned on a larger than laboratory scale.

ECONOMICS AND SOCIOLOGY

C. E. Allred

FARM TAXATION AND COUNTY GOVERNMENT

Early in the year the Department was requested by the finance division of the TERA to make a study of county finances for each of the Tennessee counties. All expenses of the study were borne by the

TERA. One statistician, two machine operators, and two stenographer-clerks were provided for a period of about six months. The TERA also requested its representatives in each county to provide us with information desired.

Results of the study were made available to cooperating agencies in five bound volumes, with a total of 2437 pages. Four of these contain the data by individual counties, all information on a given county being together. The fifth volume is a state summary, in which the more significant data on each phase of the subject is brought together and mapped on a state-wide basis.

It is expected that a condensation of this study will be published and ready for distribution during the coming year.

A circular entitled "Tax Delinquency on Rural and Other Property in Tennessee" was issued in 1935. It was based on the state-wide survey mentioned in our 1934 report.

COTTON MARKETING

The cooperative project on cotton marketing is conducted jointly with the Federal Bureau of Agricultural Economics.

Progress has been made on both the field and analytical work during the past year. Samples from almost 21 thousand bales, or 6.6 per cent of the total cotton crop of the State, were supplied by 36 cooperating ginners. These afforded a basis for the annual grade and staple estimates. An effort was made to give prompt return of the class of each of these bales to the farmers growing them.

Prices paid growers for individual bales were secured at two localities. Returns on the distances from which growers bring cotton to gins were completed. Schedule procedures to be followed in a further survey of farm practice in the production and marketing of cotton were worked out. Arrangements to continue the mill consumption study, with revised procedure, were completed.

A base map delimiting the areas from which individual gins and groups of gins draw the major portion of their cotton was prepared. Over 300 maps of variety data were charted on this base. Considerable progress was made on a manuscript tentatively entitled "Varieties and Quality of Tennessee Cotton, 1928 to 1935."

SOUTHERN APPALACHIAN STUDY

This study has been carried on cooperatively with the Federal Bureau of Agricultural Economics and the experiment stations of adjacent states. During the year a bulletin was published by the U. S. Department of Agriculture under the title "Economic and Social Problems and Conditions of the Southern Appalachians." The report embraces the equivalent of about 400 ordinary bulletin pages, thus containing as much material as a book of usual size.

RURAL RELIEF PROBLEMS

The rural social research which was under way last year in cooperation with the FERA and TERA has been continued. During 1935, surveys were made in Cocke, Jefferson, Hawkins, Anderson,

Overton, White, Grundy, Franklin, Williamson, Wayne, Houston, Stewart, Henderson, and Fayette Counties.

To date, four mimeographed reports have been issued, as follows:

Some Problems of Rural Relief in Tennessee. 19 pages.
Rural Relief and Rehabilitation Possibilities in Wayne County, Tennessee. 34 pages.
Rural Relief and Rehabilitation Possibilities in Houston County, Tennessee. 49 pages.
Rural Relief in Overton County, Tennessee. 37 pages.

Manuscripts for several other bulletins are in preparation, and will be issued in 1936.

AGRICULTURAL ADJUSTMENT

During the year the Agricultural Adjustment Administration asked the Federal Bureau of Agricultural Economics to make an analysis of the agricultural situation in every part of the United States, and recommend adjustments that would attain the double objective of being beneficial to the farmers of the respective areas and at the same time reduce burdensome surpluses. The BAE in turn requested the Agricultural Experiment Stations to undertake the task for their respective states.

This department, therefore, devoted a great deal of attention to that project during the past year. A type of farming study was already under way, and a type of farming map had been tentatively outlined. This map was completed, and available agricultural data on each area assembled and analyzed. Based on these data, and on the knowledge of the Experiment Station staff, tentative suggestions were outlined for adjusting the production of the principal agricultural commodities for each region of the State.

Upon completion of the emergency phase of the work, the type-of-farming study was resumed on a more thorough basis. The manuscript for a bulletin on that subject is now in preparation.

LAND USE

The Department has continued active cooperation with the Bureau of Agricultural Economics and with two divisions of the Resettlement Administration, in the land use studies which those agencies are conducting in the State. They have continued their headquarters in the Department, and have made extensive use of information which has accumulated there over a period of 20 years. In return, they have made available to us the results of their research.

The particular phase of the work to which we have given most attention is the collection and mapping of basic information regarding the different sections of the State. Much of the information has been presented by civil districts.

ENTOMOLOGY

S. Marcovitch

The Development of an Improved Cryolite

From the inception of the work with fluorine compounds as insecticides in 1924 an effort was made to improve their physical properties. They were not well adapted for insecticidal use, because they were too heavy, did not remain well in suspension, or lacked adhesiveness. During the past year, an improved fluorine insecticide, apparently related to cryolite, was developed in cooperation with the Aluminum Ore Company. In many respects the physical properties are even superior to those of lead arsenate.

The new cryolite is produced in a very finely divided condition, and occupies 85 to 100 cubic inches to the pound. Many of the present fluorine compounds, such as natural cryolite, occupy only 40 cubic inches to the pound. The improved cryolite is practically free from soluble fluorides and contains ingredients that impart valuable sticking properties. The suspension properties are extremely good. Tests have indicated that a large proportion will remain in suspension for several hours.

Trials made on a number of plants for foliage injury showed none whatever on apple, peach, potato, bean, cabbage, cucumber, cantaloupe, tobacco, or smartweed. Greenhouse tests on the sweet potato flea beetle (*Chaetocnema confinis*) showed excellent results from the new cryolite as compared with barium fluosilicate and calcium arsenate.

CUTWORMS

During the past season light-trap catches were made in various environments to study the nocturnal habits of cutworm moths, and in addition to determine whether the corn ear worm (*Heliothis obsoleta*) could be effectively trapped to give control of worms in tomatoes and corn.

The study was made by comparing the abundance of moths (species and number) caught simultaneously in two environments. Light traps were operated in tomato and corn environments from August 6 to August 28, and from August 30 to September 26 in tomato and fallowed-ground environments.

Seventeen species showed no preference for the tomato and corn environments. Fourteen species perferred corn, the same number tomato. The data from tomato and fallowed ground show 20 species with no preference, 22 preferring tomatoes, and 18 preferring fallowed ground.

Records for *H. obsoleta* show that 2 moths were caught in each of the tomato and corn environments and 6 each in tomato and fallowed ground. The small number indicates that light traps will not control this pest.

MEXICAN BEAN BEETLE

The Mexican bean beetle (*Epilachna corrupta*) appeared this spring in moderate abundance, and field tests under practical conditions were instituted. Several commercial cryolites and derris (Cubor)

were compared with the improved form of cryolite. The tests as indicated by the number of bean beetle larvae per row in each plot showed no larvae for the new cryolite when used at the rate of 3 pounds to 50 gallons of water. The natural cryolite showed 118, while Cubor showed but 10. The improved cryolite thus gave definitely better results than the natural cryolite and almost as good as Cubor. Considering the cost of the latter material, it is not as economical for the farmer as cryolite.

THE MORE IMPORTANT INSECT PESTS OF 1935

During the year 1935, the following insects were among the more important pests for which information was sought:

Eastern tent caterpillar (*Malacosoma americana*).—This insect was abundant enough the latter part of April to strip nearly all of the wild cherry trees. In many cases apple trees were also injured and the caterpillars became very numerous and annoying.

Tarnished plant bug (*Lygus pratensis*).—At the United States cotton-breeding field station near Knoxville, D. M. Simpson observed a poor set of fruit. Examination revealed that the tarnished plant bug was the culprit. The small cotton squares were blasted, and in many instances abnormal branching and stunting were noticed. Being a sucking insect, it was treated with sulfur and derris, but with no apparent results. Paris green with lime gave good control, as did also sodium fluosilicate.

Cotton leaf worm (*Alabama argillacea*).—This insect does not often reach Knoxville, but on August 14 was observed to be "ragging" cotton. A dust of calcium arsenate kept it in check, but was responsible for an infestation of the cotton louse (*Aphis gossypii*), through the destruction of the parasites and predators.

Lesser corn stalk borer (*Elasmopalpus lignosellus*).—Many reports of damage to corn and beans were received in September.

Potato tuber moth (*Phthorimaea operculella*).—This is the first year that specimens of this pest have been found in Tennessee.

HOME ECONOMICS

Florence L. MacLeod

The vitamin G content of green string beans, white cabbage, green cabbage, fresh English peas, and sweet potatoes has been investigated.

String beans were found to contain approximately 0.5 Bourquin-Sherman unit per gram. Additional tests are being made to check this figure.

White cabbage was found to contain 0.2 unit per gram, and green 1.0 unit per gram. Green cabbage is therefore about five times as rich a source of vitamin G as white cabbage.

Fresh English peas have been investigated, but more trials will be required to confirm the value obtained. They contain more than 1.0 unit per gram.

Sweet potatoes gave a value of approximately 0.25 unit per gram. Further determinations will be made.

EXPERIMENTS ON THE UTILIZATION OF PHOSPHATES

Experiments have been carried out since September, 1934, to determine whether dicalcium phosphate and some others manufactured by the Tennessee Valley Authority can be utilized to advantage by animals. The experiments to determine this utilization have been of two types: (1) investigations in which the object has been to show, roughly, whether the material can be used by the animal body and whether it produces any harmful effects; and (2) quantitative experiments in which the calcium and phosphorus contents in the diets have been carefully controlled, in order to determine the exact degree of utilization of these minerals. Albino rats have been used in all of the work as the experimental animals.

In the first series of experiments, which was carried out in the fall of 1934, dicalcium phosphate to the extent of one per cent was incorporated in a diet containing one-third whole milk powder and two-thirds whole wheat, by weight. This diet has been used successfully for the breeding colonies of many laboratories. It was found that the bodies of the animals receiving the diet supplemented with dicalcium phosphate contained a higher percentage of phosphorus and calcium than their litter mates receiving the milk and wheat diet without the addition. There was no difference in the growth records of the two sets of animals. It was concluded, therefore, from these results that the dicalcium phosphate has no harmful effect in animal nutrition, and that it is available for the building of bone.

For the second series of experiments which were quantitative in nature, a standardized, synthetic diet was used in which the amount and the source of calcium and phosphorus could be varied at will. With such a diet, the utilization of the phosphorus in dicalcium phosphate and in other similar phosphate products was compared with a pure chemical source of known availability. As a final check on the results obtained on the utilization of phosphorus in the Tennessee Valley Authority's dicalcium phosphate, the availability of the phosphorus in milk was compared quantitatively with that in dicalcium phosphate.

Animals receiving dicalcium phosphate in the synthetic diet have been carried into the fourth generation and compared directly with animals receiving the well-standardized, chemical salt mixture. Records for growth and reproduction have been obtained. Animals of the first and second generations are being analyzed for phosphorus at 60 and 90 days of age and those of the third generation at 60 days of age.

It can be concluded that rats receiving their entire supply of phosphorus from the dicalcium phosphate show excellent growth, fine physical appearance, and a normal storage of phosphorus in the body. The analyses for phosphorus in the animals in successive generations have not been completed at this date.

Another series of experiments of the same type has been carried out, in which the amount of phosphorus used in the synthetic diet has been reduced to a level 50 per cent below the optimum usually provided. The same type of record has been obtained as outlined in the previous experiment. It was thought that at this very low level, any difference in the availability of the phosphorus in the dicalcium phosphate from that of the accepted, standard salt mixture should be easily detectable.

Other phosphate products were investigated parallel with the dicalcium phosphate. A comparison of the utilization of the phosphorus in the Tennessee Valley Authority's product, in a dolomitic mixture and in pharmaceutical dicalcium phosphate prescribed for human consumption, has been made.

The feeding part of the final experiment, in which the utilization of the dicalcium phosphate was compared with the utilization of the phosphorus in milk, has been completed, but the animals have not been analyzed for phosphorus.

No definite conclusions from any of these experiments can be drawn, although the results to date indicate that the phosphorus in the Tennessee Valley Authority's dicalcium phosphate is well utilized. When the analyses are completed and the breeding records compiled, it is felt that it will be possible to state definitely how the availability of the phosphorus in the Tennessee Valley Authority's dicalcium phosphate compares with that of an artificial chemical mixture and of a natural food, milk, and also with that of other commercial phosphates.

HORTICULTURE

Brooks D. Drain

FIRE BLIGHT-RESISTANT PEARS

Over 2000 hybrid pear seedlings were set in nursery rows in 1935. Nearly all seedlings of Seckel parentage were highly susceptible to leaf spot, and many died from this disease. Bordeaux mixture sprays failed to check its spread after the disease had started. Seedlings resistant to fire blight were top-worked into bearing trees. A block of stock pears were set at the Mericourt Station for this purpose. Hybridization work was seriously handicapped by cold injury in the late spring, but the late-blossoming crosses were successful.

RED RASPBERRY IMPROVEMENT

Over 2000 hybrid raspberry seedlings fruited the past season and an equal number of seedlings were set in the field. Our best selections were very healthy, gave large yields, and produced fruit of excellent dessert quality. These hybrid selections vary in ease of propagation. Leaf cuttings from some seedlings rooted readily. A number failed to root from any kind of cuttings, including tip layers, and did not make suckers.

STRAWBERRY BREEDING

We started in October to transfer the strawberry-breeding project to the West Tennessee Station, at Jackson, which is in a large produc-

ing district. Freezing tests were begun on the more promising selections. Efforts to develop pure-line breeding stock were continued. The selection range now includes several hundred more or less promising varieties, which are being carefully tested. The usual block of hybrid seedlings were fall-set at Jackson.

GOOSEBERRIES

Glendale, a variety of gooseberries from the U. S. D. A. breeding work, appears to be well adapted to the climate and soil of Tennessee. Young plants have made excellent growth, appear to be healthy, and have produced moderate crops.

TRUCK CROPS

Leaf spot in tomatoes.—A part of this project was transferred from the Botany Department in May, 1935. Some crosses were made both outdoors and in the greenhouse. Additional light was necessary to secure good sets of fruit during the fall months. A selection made by the late Mr. S. H. Essary near Newport showed some resistance to leaf spots and had canning quality.

Rhubarb.—This Department has continued to import seed from foreign countries in the hope of securing some seedlings that are highly resistant to crown rot. A small block of plants from imported seed were set in the field.

Irish potatoes.—Warba, a new early variety from the Minnesota Station, gave a much larger yield than any other variety in this test. It was earlier than Triumph and of better quality, and is worthy of trial. The fall crop was ruined by an early freeze.

Asparagus.—On clay soils, asparagus was ridged just before cutting started, to increase the length of the shoots. This also helped to destroy weeds in the row.

Sweet potatoes.—A bunch, or bush, strain of Yellow Jersey continued to give somewhat better yields than the vining form and is more convenient. Maryland Gold, a golden-colored sport of Yellow Jersey, gave a good yield on the more fertile plots and was very attractive. Mameyita, a stem rot-resistant variety, was very similar to Nancy Hall in appearance and production.

Beans.—Rust-resistant pole beans from the Virginia Station were highly resistant to this disease, but failed to set commercial crops. Some varieties blossomed poorly. Kentucky Wonder gave much the larger yield, although severely attacked by rust.

Sweet corn.—Several top-cross selections of Golden Bantam appear to be very promising in this varietal trial. Worm injury was low, ears were medium in size, and quality was excellent.

ROOT-KNOT NEMATODE

Hopi lima beans showed a high resistance to nematode injury when these varieties were planted on nematode-infested soil. Susceptible lima beans had been grown on this plot the previous year. A selection of pole snap beans from the Alabama Station was resistant to nematode injury, but lacked commercial quality. Certain crop rotations were started as a means of controlling this pest.

PYRETHRUM

A thorough check-up on the high-test pyrethrum strains at this Station was made possible through the cooperation of the McLaughlin Gormley King Company, of Minneapolis. Several hundred chemical samples were taken and analyzed. Nine vegetative strains were found that ran over 1.5 per cent total pyrethrins on moisture-free basis. Determinations on individual plants within a strain showed little variation. Pyrethrum content remained fairly constant for a given strain when grown on different soils and in different environments. Nursery-plant production of the more valuable strains was started.

ORNAMENTALS

About 25 different foreign plant importations are promising in this range. This includes new species of Cotoneaster, Hypericum, jasmine, indigo, willow, and Buddleia. These new ornamentals have grown well for several seasons.

PHYSICS

K. L. Hertel

TECHNICS FOR MEASURING FIBER PROPERTIES

Seed-cotton fibrograph.—During 1935, work was continued on the development and use of the cotton fibrograph, a photoelectric instrument for the measurement of fiber length.

The accuracy and consistency of the seed-cotton fibrograph were checked by the analysis of 78 seed samples, representing 10 varieties. The fibrograms, or curves obtained on the fibrograph, were compared with curves derived from direct measurement of the same fibers. The fibrograms from at least 6 seeds must be combined to produce good agreement with the measured values.

At the suggestion of Mr. Newman Hancock, a number of seed samples were analyzed by zones. The surface of each seed was divided into 4 zones and a fibrogram was made from the lint in each zone. A further check on the fibrograph was provided by analyzing these samples by direct measurement also.

The clamped random sample.—When a sliver, roving, or any random arrangement of parallel fibers is clamped on a transverse line, the clamped fibers constitute a new type of sample. It had been shown that, theoretically, there should be a definite mathematical relationship between the fibrogram of the fibers that extend beyond the clamp edge and the length distribution of the total fiber population. This relationship was proved experimentally by comparing the fibrograms of clamped roving samples with the corresponding curves derived from the direct measurement of individual fibers in a representative sample of the same roving. The agreement was very satisfactory. Some tests were made to study the homogeneity of slivers and rovings in an effort to determine the best source for sampling.

Lint-cotton fibrograph.—On the basis of the clamped-sample analyses and the experience gained with the seed-cotton fibrograph, a new instrument was designed and constructed for the analysis of

lint cotton in the form of clamped random samples. The new fibrograph was tested and calibrated and is now giving satisfactory results. It accommodates a sample more than 6 times the size of the seed sample.

In order to make the use of the new instrument more general, a new sampling device was developed which permits the preparation of satisfactory clamped random samples directly from ginned lint, without the processing of the lint into the sliver or roving form. A number of tests have been made on material accumulated by Mr. Hancock for genetic and environmental studies, using the new fibrograph and the new sampling method. This work is still in progress.

At present, efforts are being made to develop a convenient method for mixing the cotton before sampling. No positive results are available yet. Also in progress are preliminary designs for a third fibrograph and for an experimental device to measure fiber fineness.

A paper on the "Application of the Fibrograph to Lint Cotton" was presented at the February meeting of the Southern Agricultural Workers in Atlanta; and a short talk on the project was made before the Technical Society of Knoxville on October 14. Two papers for publication are now in preparation.

In much of the routine work done, N. Y. A. student help has been used. This included routine computations, counting and measuring hundreds of thousands of fibers, ginning approximately 3000 boll samples by hand, and weighing this material.

PLANT PATHOLOGY

C. D. Sherbakoff

The studies in Plant Pathology during the year have been devoted mainly to projects previously organized, with the addition of tomato and red clover breeding, formerly conducted by the late Mr. S. H. Essary. Considerable attention must inevitably be given to the need of public organizations in the State, and of individual citizens, for assistance on plant-disease problems.

Following is a brief statement of the progress made on each of the projects that were active during the year.

WHEAT HEAD BLIGHT AND ROOT ROT

Wheat selection and breeding for disease resistance were continued, with special emphasis on (1) selection of pure lines from different varieties of wheat best adapted to our local conditions, from our own most promising crosses, and from the best wheats recently developed by others; (2) new crosses between pure lines, each possessing supplementary characters essential to the attainment of the objective—development of a variety sufficiently resistant to all of the more important diseases and at the same time agronomically good; and (3) the testing of the more promising selections in different parts of the State and on different soil types. During the fall there were planted 1659 head-row selections, 92 progenies of our own hybrids, 21

pure-line selections, and 28 selections obtained from common varieties and varieties produced by other experiment stations.

The comparison in yield of some of our wheat selections with the best of other wheats tested here, showed, as in the preceding year, that the two selections—one bearded and one beardless—stood definitely at the top of the list. The two wheats need, however, some further improvement and testing before being released for general use.

Besides the tests that are being made on the two locations at the Station farm at Knoxville, most of the better wheat selections—from 29 in some cases to 38 in others—are being tested this year in different places. These tests are distributed from the extreme eastern to the extreme western end of the State in order to determine the adaptability of the wheats to the various soil and weather conditions.

FUSARIUM WILT OF ECONOMIC CROPS

Besides the necessary attention to routine work with numerous cultures of Fusaria, new isolations were made from a large number of different host plants, especially from cotton and tomato plants affected with the wilt. Mr. J. K. Underwood has been assisting in this phase of the work.

In the field a test of the effects of different fertilizers and some other substances upon the wilt of cotton was carried on by Mr. G. M. Stone, in West Tennessee, near Martin, on soil of the so-called "buck-shot" type, deficient in potash, nitrogen, and phosphate and severely infected with the wilt and "rust." The test showed (1) that only the potash-nitrogen combination gave definite indications of reducing the amount of wilt in the susceptible variety; (2) that a reduction in the amount of wilt in the resistant variety was obtained from all soil treatments containing potash—namely, the potash-phosphate, potash-nitrogen-phosphate, and potash-nitrogen combinations; (3) that the amount of wilt is increased, in both the resistant and susceptible varieties, by soil treatment with the phosphate-nitrogen (no potash) combination; (4) that the supplementary materials, copper sulphate, zinc sulphate, and the two kinds of lime, seem to have no effect on the amount of wilt; (5) that the amount of "rust" was reduced by all fertilizer combinations containing potash.

The testing of tomatoes for resistance to Fusarium wilt, previously conducted by Mr. Essary, have been continued by this Department, with the assistance of Mr. J. O. Andes, primarily along two lines: (1) the "building up" of resistance by means of crosses, and (2) the selection of seedlings grown in soil heavily inoculated with the wilt fungus.

STRAWBERRY BLACKROOT

The strawberry seedlings and hybrids obtained in previous years which were promising in connection with blackroot resistance have been grown in test plots near Portland, on soil where blackroot conditions prevail. Some of the plants were outstanding in their ability to resist the disease, and some were promising also in yield and berry

quality. About 100 of these were set out in small plots for further testing. Progenies of some of the plants stood well, in both yield and resistance, in comparison with the strawberries commonly grown in that section of the State.

APPLE BLACK ROT AND OTHER PREVAILING DISEASES

The tests of methods of control of the more important diseases of apples, initiated in 1923, were completed this year, having yielded sufficient data to insure dependable and economic control under the conditions of commercial apple growing in the State. The information now available on the subject will be incorporated in a forthcoming revision of Bulletin No. 145 and in a new bulletin on spraying for control of plant diseases. Meanwhile the information is available in a brief form in our Circular of Information No. 19.

For the economic control of diseases in a small-scale or home orchard it would be necessary to have varieties possessing fruit of sufficiently good quality and at the same time resistant to all of the more important diseases—scab, blotch, bitter rot, and apple and quince rusts. At present there is no such variety. It is fairly certain that a variety or varieties of the kind can be developed, though it may take some 20 or more years. It is hoped that work along this line will be started shortly.

PEACH BROWN-ROT CONTROL

The experiments on control of peach brown rot were concluded this year, due to the fact that the data obtained appear to be sufficient to furnish a basis for the control of this disease.

TOMATO LEAF-SPOTS CONTROL

The project looking to the control of tomato leaf spots was organized sometime ago by Essary, and is being developed by this Department along the lines conceived by him; namely, the search for leaf spot-resistant tomatoes and testing of means of control by spraying and sanitation. This year, artificial inoculation with the disease has been employed. No variety of tomatoes used in the test showed any marked resistance to the leaf spots. It is possible, however, that Essary's selection known as Newport No. 5 has a little more resistance than other tomatoes. It is hoped that resistance may be "built up" by proper crossings.

The spraying tests showed that on ground heavily contaminated with the fungi producing leaf spot, even very good spraying, with a high-pressure power sprayer, gives no satisfactory control.

ANTHRACNOSE-RESISTANT RED CLOVER

The studies of anthracnose-resistant red clover were organized by Essary 3 years ago, with the assistance of Mr. N. I. Hancock, and have been carried on this year by the Plant Pathology Department, with the assistance of Mr. Underwood, along the lines described by Essary in the preceding annual report. The nature of the project is such that it will be at least 5 years yet before any clear-cut progress

can be reported. It can be stated, however, that the studies give promise of marked improvement in red clover.

MERICOURT EXPERIMENT STATION

H. P. Ogden

The entire front lawn of the Mericourt Experiment Station, lying between Madison Street and the fence north of range A, was leased to the city of Clarksville for a period of 50 years by the Board of Trustees of The University of Tennessee, to be used as a city park and playground.

AGRONOMY

The experiments with field crops and fertilizers were continued along the same general lines as those of the past few years.

The 5 rotations begun in 1934 comparing legumes under different lime and fertilizer conditions were continued. Effects of lime were marked on all leguminous crops except Kobe lespedeza. The difference in response to lime between Korean and Kobe lespedeza was readily apparent.

One plot of tobacco in these rotations following Korean lespedeza on limed land was almost entirely destroyed by root rot, while that on the adjoining plot following Korean lespedeza but not limed showed no evidence of the disease.

For several years comparisons were made between "high-analysis" fertilizer applied at a low rate and ordinary complete fertilizer applied at a higher rate. The total N. P. and K was the same in both cases. These applications were made without lime and also with ground limestone mixed in the fertilizer at the rate of 600 pounds per acre. These treatments were made on truck crops using the same fertilizer treatments on each plot for a series of years. The crops were shifted each year. In 1935, half of the plots were seeded to No. 76 lespedeza and the others to Korean lespedeza for the purpose of determining the residual effects of the different treatments. While differences in yields of truck crops receiving the different treatments were in favor of lime and "standard" complete fertilizer, the differences in yields of the lespedezas were very slight, probably not significant, but in favor of no lime and high-analysis fertilizers. All yields of lespedeza were high.

Fertilizer experiments in a sweet potatoes-lespedeza rotation were continued as in the past.

Varietal trials of corn and lespedezas were continued as usual.

Methods and dates of seeding sericea were conducted along the same lines as at the Knoxville Station. The results at Mericourt were more favorable for March seedings of scarified seed without a nurse crop than those at Knoxville. This may be because of very dry weather in May and June at Mericourt causing greater competition for water between the wheat and sericea. When the value of the wheat crop is taken into consideration and the saving in cost of seedbed preparation is considered, the conclusion seems warranted that seeding unscarified seed in winter or scarified seed in March or early

April, on wheat or other winter grain, is the most satisfactory way of seeding sericea. No experiments have been made, however in seeding sericea in barley or winter oats. Seedings of sericea in rye were successful.

HORTICULTURAL CROPS

Brooks D. Drain

The following is a summary of the horticultural work at Mericourt Station, Clarksville:

Apple orchard soil management.—Limed plots gave increased growth of leguminous cover crops over no-lime. This increase in cover crops plowed under gave increased growth of the trees.

Pear stock orchard.—A large block of pear stocks were set in the fall and winter of 1935. These trees will be used for top-working promising seedlings from the fire blight-resistant breeding work.

Red raspberries.—Foliage diseases caused many leaves to drop in late summer on all varieties except St. Regis. Some growth was made in the fall, but the plants were poorly matured when freezing weather started. More suckers were produced under mulch than under cultivation.

Strawberries.—A range of new selections from the strawberry breeding work at Knoxville was started this season.

Gooseberries.—Glendale, a new variety of gooseberry, made an excellent growth compared with Poorman and produced some fruit.

Asparagus.—Heavy rains following an application of calcium cyanamid prevented a good kill of chickweed on the asparagus plots.

Irish potatoes.—Warba, a new variety from the Minnesota Station, gave the largest yield in the spring-crop planting. The tubers are attractive, with pink eyes, and are of good quality. The Warba plots matured very early.

A medium spacing of Jersey Redskin gave better yields than wider spacing in the fall crop.

Pyrethrum.—Several high-test strains of pyrethrum developed at this Station were crown-divided and will be propagated as fast as possible.

Sweet potatoes.—Mameyita, a stem rot-resistant seedling, appears to be the most promising of the many seedlings tried. The roots are smooth and attractive, yield is large, and quality good.

Ornamental shrubs.—*Kerria japonica* died back badly on the limed plots and was fairly healthy on the acid soil. Crepe myrtle did much better where limed.

Blight-resistant chestnuts.—A small planting of *Castanea molissima* was made several years ago. The trees have made a nice growth and appear healthy. The few chestnuts produced to date were medium to good in quality.

MIDDLE TENNESSEE EXPERIMENT STATION

L. R. Neel

NEW PASTURE AND FORAGE WORK STARTED

Approximately 45 acres of open land has been set aside as a self-contained pasture area. In May a part of the surplus growth was mowed and put into a trench silo for winter or a dry-weather period, and at about the same time some was cut for hay, which was stacked in the field. The field was pastured in moderation until about November first, when 10 yearling steers and 10 steer calves were weighed into it to remain until they are finished for the market or are sold. The 10 older cattle are to be sold off in the summer of 1936, and in the fall more calves are to be added to make nearly full use of what the pasture produces. The number added is expected to be 10, or thereabouts, according to observations made during the year.

The cattle are to be wintered on pasture, pasture-grass silage and pasture-grass hay, supplemented by a very light grain ration. Finishing is to be done on pasture alone. In time of drouth, hay or grass silage is to be used as needed to maintain the cattle on the pasture continuously.

PASTURE-GRASS SILAGE AND HAY TESTED

In the fall a group of 10 yearling steers was placed on a ration of pasture-grass silage, to be compared with a group of 15 being fed corn-sorghum silage. Other roughage and the supplementary grain ration were the same.

At a time when hop clover and bluegrass were in proper hay stage, in May, several tons were cured in good condition and stored in barn. In the fall a group of calves were placed on a ration of this hay, along with corn-sorghum silage and light feed of corn-cob meal. Two similar groups were placed on rations of alfalfa hay. In addition to hay, all 3 groups received the same ration of corn-sorghum silage and corncob meal.

ALFALFA-BLUEGRASS FEEDING TEST

Two acres of freshly sown alfalfa and 2 acres of old alfalfa now going over to bluegrass and white clover were set aside for a beef-production test. The 4 steers to be used in this test in 1936 will be carried through the winter of 1935-36 on a straight ration of alfalfa hay. In the spring they will be pastured on bluegrass. In the pasture season they will make use of bluegrass pasture when available and alfalfa when the bluegrass dries up. Surplus growth saved on the plots as hay will be used in time of short grass in summer and as needed in winter. If additional feed is needed, more land will be added.

LESPEDEZA PASTURE STUDY

A pasture test was started to determine the value of lespedeza pasture as the season progresses from midsummer to time of killing frost in fall. Four varieties were included in test, but they will be reduced to 2—Korean and common lespedezas.

PASTURE STUDY ON HAGERSTOWN GRAVELLY LOAM

Approximately 4 acres of southern and eastern exposure, Hagerstown gravelly loam soil, were set in locust and black walnut trees with the hope of improving what has been a very poor sod. A liming test is to be added and in late winter, dallis grass is to be seeded on part of this area. The effects of shade and lime in improving bluegrass, and white clover sod, and the merit of dallis grass on this kind of soil, will be determined.

WEST TENNESSEE EXPERIMENT STATION

Ben P. Hazlewood

The West Tennessee Experiment Station was further benefited throughout 1935 by having available relief labor from the TERA for use in controlling soil erosion. Drainage ditches, tiles, and dams were generally repaired over most of the property.

Weather conditions throughout the year were unfavorable for best crop production. The month of June had an unusual number of rains, which permitted plowing only 5 days. Summer crops therefore suffered considerably from lack of work. A severe drouth was experienced during the month of August, interfering considerably with the early seeding of fall and winter crops. Killing frost occurred October 6, which was 15 days earlier than average.

In addition to various group meetings and individual visitations, the three annual meetings were held for the purpose of studying the work of the institution. The winter crops study in March was attended by 300 West Tennessee farm people. The Farmers' Institute in July had an attendance of 3,000, and the negro farmers' summer meeting was attended by 4,000. A meeting for the special study of cotton experiments in September was attended by 300 cotton farmers. The work of the institution is studied throughout the year by a large number of West Tennessee farmers and agricultural workers.

PASTURE PROGRAM

The increased attention given soil erosion has resulted in considerable interest in the all-year pasture program that has been used by the Station since 1931 in dairy- and beef-cattle experiments. The all-year pasture consists of a permanent seeding of grasses and clovers for summer, supplemented by Sudan grass in drouth periods. Crimson clover, either alone or with rye or rye grass, makes the late fall, winter, and early spring pasture. Over a 5-year period this combination of pastures has supplied an average of 332 pasture days.

DAIRY-CATTLE-FEEDING-AND-GRAZING TEST

Two groups of cattle were supplied all-year pasture, alfalfa hay, and silage. Group 1 received no supplemental grain feeding, and group 2 received a standard grain ration at the rate of 1 pound for each 3 pounds of milk produced. Otherwise the cattle were handled as nearly alike as possible. The production of the no-grain group of cattle was 90 per cent of the production of the grain-fed cattle. The physical condition of the grain-fed cattle was satisfactory. Practically

no difference in body-weight gain resulted between the two groups. The cattle fed no grain secured 75 per cent of their feed from pasture. The grain-fed cattle, under the same conditions otherwise, secured 50 per cent of their feed from pasture. If first-class all-year pasture is as cheap as barn feeding, the practice mentioned above seems to have possibilities where soil conditions are similar to those of the West Tennessee Experiment Station. Similar work with beef cattle is reported in the Animal Husbandry section of this Report.

COTTON

Cotton breeding, varieties, and new strains and selection tests are included in a Purnell project and are discussed in the Botany section of this Report. In addition to this work with varieties, this Station and the Botany Department have cooperated with the Bureau of Plant Industry, Department of Agriculture, in conducting a regional variety test, in which 16 of the generally planted cottons are included. This test offers an opportunity for an extensive study of most of the leading varieties throughout the cotton belt and is a valuable addition to the Station's cotton work. Fertilizer experiments with cotton, which have been under way for several years, were continued. They include a comparison of various sources of nitrogen and of rates of application of potash. Additional work with cotton was begun, to determine the effects of winter legumes, rye, and bare fallow on the subsequent yield.

CROP ROTATIONS

Extensive work with crop rotations has been continued. Several rotations which are now in progress, and have been, in most cases, for 26 years, offer information applicable to almost all types of farm rotations that might be considered under West Tennessee conditions. The results are very much in demand. A report of the work as a whole is not yet available, but many reports of certain phases have been made and are used extensively. The results of the use of lime in rotations which include soil-improving crops are more in evidence than those of any of the fertilizer or crop treatments. Applications of phosphate do not generally give profitable results. In these rotations, however, where heavy cropping has been practiced, evidence of phosphate response is beginning to be noted. The results of the rotations show that by the use of lime, soil-improving crops, and livestock, considerable cash-crop growing can be practiced and yet a plan of farming be arranged which will result in a gradual increase in soil fertility. The response of crops to applications of farm manure in the rotation and also on certain continuous crop plots is most interesting. Each ton of manure applied to continuous sorghum used for silage has resulted in an increase of 1.1 tons of silage. Farm manure applied to continuous corn has resulted in an annual increase per ton of manure of 3.24 bushels of grain and 268 pounds of stover.

WINTER COVER CROPS

A planting of winter crops, including vetch, Austrian winter peas, crimson clover, rye grass and rye, and the various combinations of

these crops, was continued. The greatest growth has been made by crimson clover and the various combinations including this crop. The growth of Austrian winter peas has been very satisfactory in the fall and early winter, but later from 50 to 75 per cent of the Austrian peas have died. Vetch makes very little winter cover, but grows sufficiently in April and May to produce considerable increase in soil fertility. Yields of barley and corn following crops of Austrian winter peas and crimson clover have been about equal; following vetch they have been slightly less; and following rye grass and rye, considerably less. Corn and barley following combination plantings, including any one of the legumes just mentioned and either rye or rye grass, gave yields comparable to those following the legumes alone.

The test including tomatoes, sweet potatoes, and cabbage after crimson clover, Austrian winter peas, rye, and bare fallow, were discontinued after the harvest of the 1935 crops. Yields of tomatoes were slightly greater after fallowed land than after rye, but approximately 25 per cent greater after crimson clover than after bare fallow, even with applications of nitrate of soda. Sweet potato and cabbage yields were considerably greater after crimson clover than after bare fallow or rye. Turning under the crimson clover crop preceding cabbage resulted in slow growth of the cabbage. In this test, applications of nitrate of soda were profitable after bare fallow and rye, but did not give a profitable response after crimson clover.

VARIETAL TRIALS

Corn.—Jellicorse gave greatest yields on rich land. Neal Paymaster gave second highest yields on "rich" land and first on "thin" land. Jarvis Golden Prolific continued to be the highest-yielding yellow corn. The highest-yielding white, early-maturing corn was Thompsons Prolific. This variety constantly gives yields equal or slightly superior to Jarvis and matures about 4 days earlier. Many varieties of corn have been included in the corn varietal trials, but fail to make yields equal to those mentioned above.

Soybeans.—A new variety of soybeans, Mamredo, from the Mississippi Experiment Station, has given seed yields about equal to Tokio. Hay yields have been somewhat less than Tokio. Mamredo seems to be due consideration, since the yield is satisfactory as compared with other varieties and it is reported to be a desirable bean for oil and meal production. The very early frost of 1935 resulted in either failure or very low yields for such late varieties as Biloxi and Mamloxi.

Lespedeza.—Hay yields for the various annual varieties of lespedeza ranked the same as in previous years—Tennessee 76, Kobe, common, and Korean. Early frost, however, favored the Korean, as a seed producer. The seed yields from Tennessee 76, Kobe, and common were practically a failure, but sufficient seed seems to have been produced by these varieties to assure a satisfactory stand for the coming year.

Cotton.—Results of varietal trials with cotton are given in the Botany section of this Report.

HORTICULTURAL CROPS

Brooks D. Drain

A marked change in the management of the horticultural work was made in October by the assignment of Louis A. Fister, Assistant Horticulturist, to reside in Jackson and have charge of the horticultural work at the West Tennessee Station.

Strawberry breeding.—Several thousand hybrid seedling strawberry plants were fall-set and should fruit in 1937. A range of breeding stock and one of superior seedlings selected during the past 4 years were started. The best of these new seedlings are worthy of trial as soon as plants are available.

Blakemore, Dorsett, McClintock, and Klondike lead in total production in the varietal trials. Blakemore and Klondike both ran small toward the middle of the picking season. A so-called "yellow leaf" trouble caused reduction in both quality and quantity of berries of the former variety. Rogueing appears to be the most practical control measure.

Peaches.—This Station picked an exceptionally nice crop of peaches. Ten Carman trees averaged 4 bushels per tree. Elberta gave a very light yield. Golden Jubilee, a new variety from the New Jersey Station, was picked July 1 and is promising for the fresh-fruit trade. Vainqueur, an importation from China, ripened a few days after Mayflower and is the best of that season. A number of other new varieties are making good growth and should fruit in 1936.

Apples.—Fertilizing, soil management, and pruning tests are inconclusive to date. The orchard gave a nice yield, considering the age of the trees. Some blocks averaged over 3½ bushels per tree. Fire blight caused serious injury.

Pears.—Fire blight killed a number of the less resistant trees in this plot. They were replanted with promising resistant seedlings from the Knoxville Station breeding work.

Grapes.—Concord gave the best yield, 3.8 tons on an acre basis. However, this planting is decrepit and needs replacement.

Raspberries.—Latham is the best commercial red raspberry in the planting, but suffers severely from leaf spot. St. Regis gives the best yield, but the fruit is low in dessert quality and small in size. Chief starts to ripen a few days after St. Regis and is of medium size.

TRUCK CROPS

Asparagus.—Mary Washington asparagus gave a good yield in this young planting. The shallow planting, 5 inches deep, gave much the largest yield—over two and one-half times that planted 11 inches deep. This was due partly to a better stand, but largely to better growth.

Sweet potatoes.—Eight stem rot-resistant seedlings from the U. S. D. A. breeding work were planted on the farm of Mr. Nant, at Gleason, Tennessee. All of the seedlings were more resistant than Nancy Hall, although they suffered slightly from this disease. Mr.

G. M. Stone, of the Pathology Department, cooperated in taking field notes. Mameyita is the most promising commercially of these seedlings and is of the Nancy Hall type.

Tomatoes.—Break O'Day and Pritchard gave an early and large yield, about 9 tons on an acre basis. Three new varieties from Idaho were very early, but lower in total production.

Cabbage.—A trial of home-grown versus shipped-in plants for the early crop was inconclusive. Much depends on the quality of the plants in each case.

Irish potatoes.—Cobbler continued to lead in total production for the early crop, although somewhat off in stand. Triumph matures early but did not yield as well.

An extensive truck-crop soil-management test was started in 1934. This includes various rotations that are likely to maintain soil fertility without the use of very much stable manure. It must be carried on for several years before any conclusions can be drawn.

TOBACCO STATION AT GREENEVILLE

Frank S. Chance

The 1935 growing season was almost ideal for summer crops. Results from the tobacco plots were all that could be hoped for. The only criticism that might be offered is that many varieties which had proved to be inferior under less favorable conditions yielded excellent-quality leaf this year. It seems that if the growing season each year were ideal, a wider selection of varieties could be used.

In the tests for root-rot resistance, 19 strains of white Burley were used. All of these showed some injury from the disease, when the quality was compared with that grown on disease-free soil. The soil used has been in tobacco for 6 consecutive years. The injury to some of the varieties has been severe for the past 4 years. Some of the varieties made good growth and produced as many pounds as could be expected, but the quality of leaf was poor.

On a series of plots where Judy's Pride is being compared with a black root rot-resistant strain, on both limed and unlimed soil, Judy's Pride was affected the second year on limed soil and the third year on unlimed soil. The resistant strain showed no ill effects from the disease in either case.

A new series of fertilizer tests was started this year on a poor gray-colored dolomite soil which had not been in a cultivated crop for the past 5 years. The plots that received no phosphate produced little more than those with no fertilizer of any kind. The plots without potash also were almost worthless. The results of this year's work indicate that at least 48 pounds of available K_2O plus phosphate and nitrogen is essential to profitable tobacco production on dolomite ridge soil.

With the help of Tennessee Emergency Relief labor, the banks of Richland Creek, which runs for almost a mile through the farm,

were cleared of undesirable trees and brush. Stone was crushed to resurface one mile of farm roads; 300 rods of woven-wire fence was built around permanent pasture fields; and 800 feet of board fence was built around barn lots. A concrete silo, 12 feet in diameter and 36 feet high, was constructed at the cattle barn.

The Tennessee Valley Authority cooperated with us in building a tobacco-curing barn, 24 feet by 60 feet, and 30 feet high. They bought materials and the Station furnished the labor and the framing, which was sawed from timber on the farm. This barn is designed for experimental curing tests. It is equipped with electric fans and heating units, for the control of temperature and humidity.

A new farm of 160 acres was added to the Station. The Greene County Court appropriated enough funds to pay half the cost of the tract. This addition is to be used for the study of soil-erosion control and for cattle-grazing experiments. Much of this farm is poor, and all of it is in a low state of cultivation. Stumps were removed from 8 acres, and 30 acres were terraced during the summer.

LIBRARY

Sarah C. Currell

The Experiment Station library has a collection of 10,368 volumes. This is an increase of 1,643 volumes for a period of five years; 257 volumes having been added in 1931, 460 in 1932, 322 in 1933, 258 in 1934, and 346 in 1935. These figures indicate that notwithstanding reduced appropriations the work has moved steadily forward.

During the five years, 1,068 volumes have been prepared for the bindery, bound and catalogued. The cost of binding was $1,401.44. There is no more judicious expenditure, as there is no other satisfactory way for a library to preserve its collection.

The Station has on its list about 275 scientific and technical journals, including some complete sets. A large number of these are foreign. Some are subscribed to, others are either donations or exchanges, and a small percentage have ceased publication or been discontinued. This part of the collection is indispensable to a research library.

The libraries of the College and Station are administered as two separate collections as to shelving and ownership, but as a unit in respect to catalog and other records and to service. In effect, the Station books form the reference collection and the College books the circulating collection of the unit. Together they constitute a branch of the University Library. The Agricultural College collection has been considerably increased this year by a number of farm papers gathered together and presented by Mr. M. V. Koger, one of the county agents.

"A Union List of Serials currently received in Southern Libraries" is being prepared under the supervision of the American Library Association's Committee on the Resources of Southern Libraries, and the periodicals in our Station and College libraries will be included

in this list. On checking our holdings, we find our contribution will be most creditable, as we were able to add a very considerable number of titles to the preliminary list. This list will be an invaluable help to research workers.

The FERA appropriation enables the libraries of the Experiment Station and the College of Agriculture to employ regularly a student who devotes 50 hours per month to library work.

The library hours have been lengthened. This has been made possible through the employment by the University of another student assistant, who keeps the library open during the noon hour and until five in the afternoon—on Saturdays until 12:30.

During the summer of 1935, the entire Experiment Station collection was reshelved and dusted. Space was allotted for future growth. The increase in the collection made this work absolutely necessary. The library is now far more usable to the workers.

This library serves the staff members of the Station and the substations, the faculty and students of the College of Agriculture, the Junior College at Martin, the Agricultural Extension Service, the Tennessee Valley Authority, and other research workers needing assistance.